SEWAGE DISPOSAL

CALIFORNIA STATE BOARD OF HEALTH

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REGULAR MEETINGS

The meetings of the California State Board of Health are held regularly the first Saturday of each month, but the quarterly meetings required by law to be held at the Capitol of the State are ordinarily designated as January, April, July, and October.

By courtesy of the University of California the Food and Drug Laboratory and the Hygienic Laboratory are located in University buildings at Berkeley, California.

Address all general communications to the

SECRETARY, Sacramento, California.

NOVEMBER BULLETIN.

COMMENTS.

An Announcement. Owing to the constantly increasing demand for copies of the State Board of Health Bulletin, the number of persons requesting that their names be placed on the mailing list has become much larger than the number of copies that can be printed for the small appropriation available. The March (1911) number dealing with sewerage and sewage disposal is out of print. In order to supply the requests for the principal articles contained in that number, they have been reprinted with this issue, but omitted in binding all copies except those sent to the libraries of the State and to persons not on the mailing list in March, 1911. By this means four thousand bulletin-separates have been obtained for distribution among citizens applying for this special information. This incomplete copy contains the vital statistics and other reports in regular sequence, and the omitted portion will be forwarded to any one who does not have the March, 1911, number.

* * * *

The Dangers of the Sewage "Well." A very dangerous method of solving the immediate family problem of sewage disposal is unfortunately becoming prevalent in California. As communities are becoming large enough to provide themselves with town water supplies which cost less than the maintenance of individual wells, and afford the opportunity for having water piped throughout the house at a greatly less expense than individual pressure tanks can be provided for. Many of the people are abandoning their wells and connecting them with septic tanks and cesspools in order to dispose of their sewage effluent. An intercommunicating and direct system of sewage pollution of the water-bearing strata underlying many towns and residential districts is thus being established. The wells which still remain in use become an unknown factor in spreading water-borne diseases and constitute a potential source for explosive epidemics of typhoid fever or other intestinal disease.

The Ohio state regulations do not permit even a "watertight cesspool to be located within 30 feet of any well or spring, nor a leaching cesspool within 100 feet of any dwelling or 300 feet of any source of water supply." The new water-pollution law of California authorizes the State Board of Health to protect well waters from pollution, and this problem is now being studied with the purpose of making regulations toward this end.

There are many epidemics on record showing that underground communication has existed for years between a residence well and a neighboring cesspool or privy vault without resulting in outbreaks of disease until a typhoid case developed in the house owning the privy vault, when the disease "germs" escaping from the body of the patient were thrown into the vault and found their way into the well-water, and thence into the intestinal tracts of the persons drinking the water. In some instances this well-water was used to wash milk cans and bottles and so carried the disease to customers of the dairyman many miles away.

An unusually clear demonstration of this potential danger from underground pollution of wells occurred toward the close of the great typhoid fever outbreak at Ithica and Cornell University in 1903. The town water supply (which was drawn without filteration from a surface stream) became polluted with the typhoid fever discharges of some patients upstream, and several thousand cases occurred among the citizens as a result. During this epidemic hundreds of persons temporarily went to a private well in one part of the city to get their water. It was not known until after a typhoid case developed in a house having a cesspool within 100 feet of this well, that the cesspool and the well had an underground communication. This fact was found out through the sudden development of fifty or sixty more cases, all among the persons who had abandoned the city water for this supposedly safe well-water, in the hope of escaping the typhoid fever. Chemical and bacteriological examination of the water proved its pollution, and through other tests and methods this particular cesspool was proved to be the source of infection.

* * * *

The Problem of the House Without a Sewer.

The house without modern plumbing, and with insufficient water supply to operate a water-carrier system of sewerage is a common type in California towns as well as in the rural districts. Many of these houses are so situated, and have enough water to operate one or two toilets, if bath and kitchen tubs and sinks are not added. In southern California many suburban homes have all the comforts of bath, kitchen, and toilet plumbing under conditions requiring the greatest economy of water and precluding any soil-percolation of the human excreta portions of sewage. These houses connect the bath plumbing directly with loose tile laid a few inches below the surface of a small lawn. The kitchen trap is connected directly with perforated square tile (with removable top side for cleaning) leading to the loose earth of a small garden patch. The toilet is separately plumbed and connected with a cement water-tight cesspool, which has to be pumped out at intervals and the contents hauled away. By adjustment of the quantity of flush water and training the members of the family to conserve the water, a tank 6 feet by 6 feet by 6 feet or 8 feet has served an average family for a year before being pumped out. The charge for emptying a tank of the size mentioned varies from $3.00 to $10.00, depending on location and accessibility.

Those houses which can not profitably adopt water-carrier systems should construct with equal care dry-earth toilets or sanitary privies. The cut printed on page 130 shows the type of privy being advocated throughout the south in connection with the campaign against the hook-worm, typhoid fever, and similarly spread diseases. When earth pits are dug they should be made tight, except for a proper vent, and fly-proof. The provision of a box of dry pulverized earth for covering each deposit of bowel discharges and the use of fine toilet-paper will practically eliminate odors, and to some extent reduce the dangers of water-supply contamination and fly transmission of disease.

* * * *

Small Sewage Disposal Works. The two excellent articles reprinted in this issue of the bulletin cover the essential factors to be considered in connection with the sewage disposal problem; but they can of course only present the general subject without going into construction details. It is to be regretted that the State Board of Health is not equipped with the means for making local preliminary surveys for small towns, summer resorts and growing suburban communities, in order to supplement theoretical discussion of their sewerage needs by definite advice as to just what should be done. It is desirable (and necessary if success is to be assured) that competent sanitary engineers should draft the actual plans for final adoption and should supervise the construction of all sewerage systems, but before the bond issue is voted upon or a contract let the people should have the advantage of intelligent, disinterested, specific advice upon which to base their action. Unfortunately it does not often happen the people put money into preliminary investigations and advice along such lines. The money wasted annually by cities, towns and individuals in blindly experimenting with their sewerage systems would provide the salaries and expenses of a competent engineering division, capable of advising helpfully all the towns and citizens of the State. It is to be hoped that the next legislature will again appropriate funds for an advisory engineering division of the State Board of Health, and that the Governor will then sign the bill.

Previous numbers of this bulletin have contained suggestive drawings and estimates of the cost of constructing small sewage disposal works, but it has been found that the errors in applying these suggestions without first consulting a sanitary engineer have been so frequent and serious that it is doubtful whether anything more than general articles such as the ones published below should be circulated.

Relative to the cost of constructing a septic tank disposal system for an average family (six members or less) it may be stated that, where porous ground with a low ground-water level exists, the cost should not be over $100 to $150 for the tanks and necessary distribution tiling. Probably $250 to $1,000 will cover the costs of disposal plants for larger residences and our mountain hotels. Extracts from an excellent article on residential sewage disposal by the chief engineer of the Ohio State Board of Health have been added to Mr. Baker's article.

THE SEWAGE PROBLEM AND THE LAW.

By W. F. SNOW and E. K. MIDDLEHOFF.

California's sewage problem presents an interesting study. In 1910 61.8 per cent of the population lived in seventy cities of over 2,500 inhabitants each. Of the remaining 38.2 per cent a considerable number, namely, 153,000, or 6.4 per cent, lived in 128 towns of sufficient size to be incorporated, and a smaller number lived in villages. The number of incorporated towns has now increased to 213, and many additional unincorporated communities have been built up. It is desirable that the health of all of this urban population should be safeguarded by the installation of adequate sewerage and sewage-disposal systems. At the present time many of these cities and towns are situated on important watersheds of the State and sewer directly into rivers. Some of them are crossed by great irrigating ditches into which much of their sewage and garbage finds its way. Others sewer directly into the Pacific Ocean, or one of the salt-water bays. A few are situated on fresh water lakes. Finally, many of the smaller cities have developed in the great level valleys of the State far from any surface-water course, but only a few feet vertically above water-bearing gravels, into which both wells and cesspools have been plentifully dug by uninformed citizens.

Californians love their mountains and from May to September they fill the great canyons at the headwaters of all the rivers with populous camps of a constantly changing citizenship. The lumber and mining industries provide many other summer cities on the banks of the mountain streams.

The long, dry summer months, followed by the heavy autumnal rains that wash suddenly the accumulated débris and sewage of the creek beds into the rivers, present a problem very different from that of a state in which frequent summer storms drench the watersheds and flush the creeks. The flooding of various sections of the State by rivers overflowing their banks and levees is a frequent occurrence. The steamer traffic on the great waterways of the State—notably the San Joaquin and Sacramento rivers—is an important factor in the sewage-pollution problem. The "intake" pipe of one river community of 1,000 inhabitants is passed daily by a floating population of more than 600.

The long, dry season mentioned precludes in California the use of cisterns for rain water. Consequently, the domestic water supplies are from shallow and deep wells, springs, rivers, open ditches, and pipeline supplies from mountain watersheds, and a few lakes. Wells and the mountain watersheds supply the majority of citizens, but each of the other sources is widely utilized. There are many instances of serious pollution of water supplies in all these classes. California's population is rapidly increasing, and every effort should be made to prevent further pollution of the water supplies. The State Board of Health is exerting the extent of its authority, under the new stream-pollution law, to remove the more serious sources of pollution already existing.

There are certain factors which operate to reduce the probable danger from all these sources of water pollution. The rivers of the State are relatively low in volume and run very sluggishly during the summer, the absence of rains precluding pollution except by materials directly discharged into them. The larger streams receive so much fine silt that a steady sedimentation goes on throughout their course through the valleys. This "muddy" condition also leads to more or less effective filteration plans for the majority of users. In winter the volume of rain and mented snow water is very great compared to the amount of pollution present. Many of the well waters contain such a high percentage of "temporary hardness" that some of the water used for drinking and cooking is boiled to "soften it," and this effectively reduces the danger from contamination, but does not eliminate all danger.

California to-day stands on the threshold of her water and sewage problem. Her promotion committees are advertising the wonderful agricultural and commercial resources of the State, and are bringing in thousands of new citizens each year. With this increased density of population will come a repetition of the pollution tragedies of the Hudson, the Ohio or the Mississippi watersheds, which were enacted at a time when science could not offer a warning. To prevent this misfortune the State law covering the pollution of water supplies was so amended by the 1911 Legislature as to give the State Board of Health the necessary authority to supervise the installation of all sewerage systems designed to discharge the final effluent in any surface or underground source of domestic water supply. The important provisions of this new law are as follows:

What constitutes stream pollution.

Section 2. It shall be unlawful to discharge or deposit, or cause or suffer to be discharged or deposited, any sewage, garbage, feculent matter, offal, refuse, filth, or any animal, mineral, or vegetable matter or substance, offensive, injurious, or dangerous to health, in any springs, streams, rivers, lakes, tributaries thereof, wells or other waters used or intended to be used for human or animal consumption or for domestic purposes; or to discharge or deposit, or cause or suffer to be discharged or deposited, any such offensive, injurious or dangerous matter or substance upon the land or place adjoining such waters so as to cause or suffer such matter or substance to flow or be emptied or drained into such waters.

It shall also be unlawful to erect, construct, excavate, or maintain, or cause to be erected, constructed, excavated, or maintained, any privy, vault, cesspool, sewer pipes or conduits, or other pipes or conduits, for the discharge of impure waters, gas, vapors, oils, acids, tar, or other matter or substance offensive, injurious, or dangerous to health, whereby any part of such matter or substance shall empty, flow, seep, drain, condense or otherwise pollute or affect any of such waters so intended for human or animal consumption or for domestic purposes; or to erect or maintain any permanent or temporary house, camp, or tent, so near to such springs, streams, rivers, lakes, tributaries, or other sources of water supply, as to cause or suffer the drainage, seepage, or flow of impure waters, or any other liquids, or the discharge or deposit therefrom, of any animal, mineral, or vegetable matter, to corrupt or pollute such waters.

It shall also be unlawful for the owner, tenant, lessee or occupant of any houseboat or boat intended for or capable of being used as a residence, house, dwelling or habitation, or for the agent of such owner, tenant, lessee or occupant to moor or anchor the same or permit the same to be moored or anchored in or on any river or stream, the waters of which are used for drinking or domestic purposes by any city, town or village within a distance of two miles above the intake or place where such city, town or village water system takes water from such river or stream; *provided, however,* that in the transportation of any such house-boat on any such river or stream nothing herein contained shall prevent the owner, agent, tenant or occupant of such house-boat from mooring or anchoring the same when necessary within the limits herein fixed and established; *provided,* such house-boat shall not remain moored or anchored within such limits for a longer period than one day.

Must obtain permit to discharge sewage in stream.

Sec. 2. Section 3 of said act is hereby amended to read as follows:

Section 3. Whenever any county, city and county, city, town, village, district, community, institution, person, firm or corporation, shall desire to deposit or discharge, or to continue to deposit or discharge into any stream, river, lake, or tributary thereof, or into any other waters used or intended to be used for human or animal consumption or for domestic purposes, or into or upon any place the surface or subterranean drainage from which may run or percolate into any such stream, river, lake, tributary or other waters, any sewage, sewage effluent, or other substance by the terms of section 2 of this act forbidden so to be deposited or discharged, may file with the State Board of Health a petition for permission so to do, together with a com-

plete and detailed plan, description and history of the existing or proposed works or system, and purification plant, showing geographical location with relation to such stream, river, lake, tributary or other waters, and a physical and bacteriological analysis of the substance or substances so to be deposited or discharged.

Penalty for failure to comply with the law.

Any county, city and county, city, town, village, district, community, institution, person, firm or corporation, who shall deposit, discharge or continue to deposit or discharge, into any stream, river, lake, or tributary thereof, or into any other waters, used or intended to be used for human or animal consumption or for domestic purposes, or into or upon any place the surface or subterranean drainage from which may run or percolate into any such stream, river, lake, tributary or other waters, any sewage, sewage effluent or other substance by the terms of section 2 of this act forbidden so to be deposited or discharged, without having an unrevoked permit so to do, as in this act provided, may be enjoined from so doing by any court of competent jurisdiction at the suit of any person or municipal corporation whose supply of water for human or animal consumption or for domestic purposes is taken from such stream, river, or other running water at a point below the place of such discharge or deposit, or from such lake, or at the suit of the State of California, or at the suit of any county, or city and county, any of the residents of which shall take water from such stream, river or other running water at a point below the place of such discharge or deposit, or from such lake or reservoir, or at the suit of the State Board of Health.

The enforcement of this law by the State Board of Health justly and with effectiveness is most difficult, but steady progress is being made. There are three distinct phases of the practical problem; (1) the large cities that have such a large volume of sewage or are so situated that disposal by broad irrigation is not available; (2) the small city which is so small or is so scattered over a large land area that its citizens can not afford the initial expense and up-keep of a modern sewerage system; (3) the country residences, summer hotels and farmhouses. The articles by Professor Hyde and Mr. Baker, published in this bulletin, are excellent summaries of the scientific principles involved in sewage disposal.

Of the total urban population mentioned above, nearly the entire number is in towns and cities already provided with some form of sewer system. Many of these are inadequate or have, like Topsy, "just growed," without any human agency directing their growth toward a final solution of the problem. Among the sewerage systems in operation in California the following types may be found:

Septic tanks—the effluent being used for irrigation: Bakersfield, Corona, Covina, El Centro, Eldridge, Folsom, Fresno, Hermosa Beach, Hanford, Imperial, Lemoore, Livermore, Los Banos, Merced, Orange, Oxnard, Patton, Pleasanton, Pomona, Porterville, Redondo Beach, Riverside, Santa Ana, Santa Rosa, Sawtelle, Selma, Turlock, and Whittier.

Septic tanks, the effluent being discharged directly or indirectly into streams: Auburn, Colusa, Gilroy, Larkspur Sanitary District No. 4, La Jolla, Los Gatos, Lodi, Naples, Tulare, and Ukiah.

Settling tank: Dinuba.

Electrolytic treatment: Santa Monica.

In the following cities new sewerage systems are either proposed or in course of construction: Lindsay, Rio Vista, Colfax, Saratoga, Sanitary District No. 1, Red Bluff, Placerville, and Santa Monica.

A REVIEW OF SOME AVAILABLE METHODS OF SEWAGE TREATMENT FOR CALIFORNIA.

By **Charles Gilman Hyde**, Consulting Engineer, California State Board of Health.

PRELIMINARY CONSIDERATIONS.

Foreword.

The sewage treatment problem is by no means a simple one. The purification of domestic wastes only, offers the least difficulty; the treatment of mixed wastes (domestic, trade, and street) may occasionally present features of utmost difficulty. Each case is more or less completely a law unto itself. It is folly to suppose, as is so often done, that because town X can dispose of its sewage successfully in some certain fashion, town Y can adopt the same method with a certainty of securing equally satisfactory results. As will be shown forthwith, sewages differ widely in character and composition, not only as between towns, but in a given town as between seasons, days of the week and even hours of the day. The only rational method of attacking the sewage treatment problem for a community wherein sewers are already in operation, is to carefully determine the regimen of sewage flow by measurement and its character by analytical methods. For towns projecting sewerage and sewage disposal works comparisons must be made with other towns having quite similar conditions. There can be no question but that specially trained and experienced sanitary engineers are needed for the design of the more refined and effective works for sewage treatment. The whole subject of sewage disposal is worthy of and demands careful study.

With the exception of a comparatively few places where sewage farming or broad irrigation of sewage has been introduced, almost the only type of sewage purification works to be found in California to-day are septic tanks, so-called, fully "fifty-seven varieties" in all, differing as to shape, relative size, etc. Many of these are operating very indifferently well and some very badly indeed. The general situation shows plainly the need of expert advice to municipalities with respect to general methods and necessary efficiencies from some central advisory authority. To every student of this matter it is clear that this body should be the State Board of Health, which should be furnished with ample funds to develop and maintain a corps of trained and capable sanitary engineers. This has been done with the greatest success and efficiency in Massachusetts for more than twenty years, in Ohio for ten years, and in other states, such as New York and Pennsylvania, during shorter periods of time.

Purpose of article.

It is the purpose of the present article to outline in brief and untechnical terms some of the most available rational processes of sewage treatment adapted and adaptable to California conditions. It is especially hoped to show that there are available processes of treatment of sewage other than by the septic tank, which has been very must over-exploited in this section. Features of design and construction, being peculiarly engineering problems, will not be discussed in detail.

Character and composition of sewage.

A fundamental characteristic of sewage, and one which bears immediately upon the sewage treatment problem, is that it consists of two very definite and distinct parts, namely, a conveying liquid and suspended solids. Sewage is the water supply of the community—except that portion which is used on lawns, gardens, etc., and which does not reach the sewers—conveying fœcal, bath, kitchen, laundry, industrial, street, and other wastes. The conveying liquid is usually rich in dissolved organic matter, most of which is readily decomposable or putrescible and extremely high in its content of bacteria. The sludge is more resistant in composition, but extremely rich in organic matter, very putrescible and high in its content of bacteria. At the usual velocities obtaining in sewers the solids are kept in suspension, but when the velocity is checked and reduced to a very slow forward motion, as in precipitation basins, septic tanks, etc., these suspended solids tend to settle from the sewage, forming a sludge, and leaving a supernatant, milky, fairly turbid liquid. In this liquid are collodial substances, on the border-line between solution and suspension, which will not settle until changed in character.

Messrs. Kinnicutt, Windslow, and Pratt have very clearly exhibited in tabular form the general character of the sewage of an American residential town as respects solid matter, as follows:

Solid matter, 200–800 parts per million.	Inoffensive, mineral, 50 per cent	In solution, 75 per cent. In suspension, 25 per cent
	Offensive, vegetable and animal, 50 per cent	In solution, 60 per cent. In suspension, 40 per cent.

All sewages are very unstable, and their composition at any time is determined not merely by the character of the initial fresh, raw product, but also by the extent of the changes which have been wrought therein, mainly by the action of bacteria but partly by chemical action. Due to these changes, which arise or set about as soon as sewage is received into the sewers, it is to be remembered that the distance and rate of travel may become important factors determining the state of a sewage when it arrives at the disposal works and defining the optimum period of storage in septic tanks, etc.

The character of a municipal sewage varies with the habits of the people as respects the use and waste of water, with climatic conditions, with the amount and character of trade and industrial wastes, with the infiltration of ground-water, etc. In some communities the wastes from a single large industry, such as a cannery, creamery, tannery, brewery, strawboard factory, wool scouring shop, dyeing and cleaning works, etc., may, during certain hours of the day, predominate over all other wastes, changing the character of the sewage very materially. It must be clear, from a consideration of the action and interaction of these principal governing factors, that the character of sewage must be very different in different communities, and in a given community at different seasons of the year, different days of the week, and even different times during the day. A recognition and determination of these differences are essential to success in a sewage treatment problem. The analytical determination of the character of sewages requires training, experience and equipment. Such work should be done by the State Board of Health for all communities—at any rate for all towns and cities except, perhaps, the largest, which may happen to be provided with their own properly equipped laboratories and trained analysts. It is a striking fact that practically no sewage analyses have been made in California, and virtually nothing is known with respect to the character and composition of the sewages of our municipalities or of the sanitary efficiency of our treatment works.

Disposal by dilution.

Except for those cities and towns situated upon the coast or upon great tidal bodies of water, such as San Francisco Bay, the opportunity for disposal of sewage by dilution is generally lacking in California. Few of our river systems, except perhaps the Sacramento and San Joaquin rivers, yield a sufficiently large and constant discharge to permit of disposing any considerable quantities of sewage therein without creating a nuisance. Experience elsewhere has demonstrated rather definitely that a nuisance will surely be caused if sewage is diluted with less than about twenty volumes of water, while from forty to fifty volumes may in some cases be necessary to certainly prevent a nuisance. Of course, these values refer to low flow, if not to minimum flow, conditions in streams. In the January issue of the Bulletin, Mr. Griswold has discussed the action of self-purification in streams and has presented an outline of the conditions which determine the extent and efficiency of this action. The conditions which may define the term "nuisance" in connection with river pollution are: The formation of deposits of sludge on the banks and in the beds of the streams; the production of turbidity, milkiness, oiliness and discoloration of the water; the formation of gases of decomposition, principally sulphuretted hydrogen, causing very bad odors; the formation from sludge of masses of scum which float upon the water, due to the bubbles of gas contained; the destruction of fish, etc.

But the problem of disposal by dilution is much broader than the mere question of whether, on the one hand, a nuisance will be caused or, on the other, the self-purifying power of the stream will be sufficient to maintain its sightliness and æsthetic character. Of far greater importance are the questions of adaptability to water supply and industrial purposes, the promotion and conservation of the health of residents in the vicinity, and the possibility of indulging in water sports, etc., without undue danger. The rivers of California are of priceless value to the State and its people and should not be made to serve as sewers for the removal of the wastes of an ever-increasing population.

The laws of the State of California with respect to the control of the purity of inland waters are now, thanks to the work of the legislature in its last regular session, quite satisfactory. There are still, however, many things to be accomplished, both from the standpoint of legislative action and from that of administration. It seems clear that broader powers must be given to the State Board of Health together with largely increased funds to provide the machinery for carrying on the work which demands more or less immediate attention.

With respect to the taking of water supplies from streams into which sewage or sewage effluents find their way, a careful review of the situation by sanitary engineers has led to the following fairly well-crystallized conclusions:

(1) No surface waters receiving sewage or the effluents of sewage treatment works are suitable for water supply purposes without purification.

(2) The discharge of crude or of partially purified effluents into such streams must at all points be well below the limit within which self-purification can readily be accomplished.

(3) All supplies of water derived from sewage polluted streams must be purified in accordance with methods adapted to the particular conditions of the stream in question.

Required degree of sewage purification.

From the preceding discussion it will be seen that the required degree of purification, or, in other words, the efficiency of the removal of the polluting matters in sewage, must be determined in any given case from considerations of the amount and character of the sewage, the regimen of the stream, the self-purifying capacity of the stream, the utilization of the stream for water supply purposes, etc. Different methods of sewage treatment naturally yield different efficiencies, and certain methods of treatment may be modified and adjusted to yield different degrees of purification according to requirements.

METHODS OF TREATMENT.

General classification.

The various available known methods of sewage treatment may be classed in three distinct and important groups, as follows:

(*a*) Those which remove more or less of the solids, especially the suspended matters, but from which the effluent is chemically unstable and capable of further decomposition and putrefactive changes. Methods in this class may be called "preliminary" or "preparatory."

(*b*) Those which remove a substantial proportion of the dissolved and suspended mineral and organic matter and which produce an effluent of fairly stable composition requiring only a moderate degree of further oxidation to render wholly stable. These methods may be called "final."

(*c*) Those which destroy the bacteria, especially the pathogenic or disease-producing bacteria, but which in themselves do not effect any material change in the physical or chemical character of the sewage. These methods may be called "disinfection" methods.

When class (*b*) methods are used, it has recently been customary to provide some preliminary treatment in accordance with one or more of the methods in class (*a*). In important cases, especially during the prevalence of epidemics of intestinal diseases, class (*c*) methods may be applied to supplement the work of either or both class (*a*) and (*b*) methods.

(*a*) *"Preliminary" methods of treatment.*

The various preliminary or preparatory methods of treatment in vogue to-day, named in order of their general efficiency, from the least to the greatest, in the removal of suspended matters, are as follows:

(1) Grit removal.
(2) Screening, corase and fine.
(3) Plain sedimentation.
(4) Straining or roughing.
(5) Chemical precipitation.
(6) Septic tank processes {In Cameron type septic tanks. / In Imhoff type septic tanks.}
(7) Contact beds—single.

(*b*) *"Final" methods of treatment.*

The various methods of treatment which ordinarily do or may produce effluents of such a stable character as to entitle them to be classed as "final" methods are the following, named in the order of efficiency of removal of organic matter from the least to the greatest:

(8) Contact beds—double.
(9) Trickling, percolating or sprinkling filters.
(10) Intermittent filtration through sand.
(11) Broad irrigation or sewage farming.

(*c*) *Disinfection of sewage.*

The particular method of disinfection of sewage and sewage filter effluents which is in use to-day in the United States is the following:

(12) Hypochlorite (bleaching powder) disinfection.

(1) *Grit removal.*

Grit chambers are designed with a view to remove from sewage the coarser suspended mineral matter which settles rapidly, due to its high specific gravity and mass, and such matters only. These materials should be found only in combined sewages which receive street wastes. In Europe the silt and other coarse materials removable by grit chambers or basins are known as "road detritus." Grit chambers are usually unnecessary in works treating domestic sewage. In the treatment of combined sewages they are of value as preliminary to disposal by dilution and as precedent to subsidence of all types, plain, coagulated, and septic.

Grit chambers should be sufficiently large to intercept the heavy mineral matter and yet so small that no significant proportion of organic matter will be deposited. The capacity should as a rule be such that a net period of storage of at least three minutes is allowed, but the forward velocity should not be less than 5 feet per minute.

In some cases where grit chambers have been constructed in California in connection with septic tanks, they have been made so large that violent septic action, accompanied with excessive scum formation, takes place in them. This is, of course, very undesirable. It is apparent that if grit chambers are needed they should be carefully proportioned and arranged in multiple units, both for purposes of cleaning and with a view to maintain a more or less definite period of subsidence notwithstanding changes in rate of sewage flow.

(2) *Screening, coarse and fine.*

The object of screening is the removal of the coarser suspended matters in sewage. The modern tendency is toward the use of constantly finer screens, mechanically operated. Screens have always been considered of value in connection with sewage pumping works and inverted syphons. More recently it has been discovered that screening may be of substantial advantage in cases where otherwise untreated sewage is disposed of by diluting in water, or where otherwise unprepared sewage is to be applied directly to a final process such as contact beds, percolating filters, intermittent sand filters or sewage farms. Screens may even be of advantage in connection with the septic process, because of the removal thereby of considerable volumes of light materials which might otherwise float on the surface and unduly increase the amount of scum.

The efficiency of the process depends entirely upon the size of mesh or openings through which the sewage is passed. With ordinary hand-cleaned bar screens from 2 to 10 per cent of suspended matter is removed; mechanically operated self-cleaning sieves may remove as much as from 20 to 25 per cent of the suspended matters. The volume of material removed by bar screens from American sewages is from 2.5 to 6.0 cubic feet per million gallons, while with mechanical sieves this quantity may be from 20 to 40 cubic feet. The amount of moisture contained in the screenings from the finer sieves is greater than in material removed by bar screens.

(3) *Plain sedimentation.*

By means of plain subsidence in properly designed basins it has been attempted at various places in America and Europe to remove from the sewage the suspended materials or sludge, which have been shown to be a most troublesome element in sewage purification. In practice the period of storage in such tanks varies considerably. The earlier plants were constructed on what is known as the fill and draw principle, but most of the later plants are operated on what is known as the continuous flow principle. In the latter type from six to twelve hours probably represents the range in storage period for American sewages. In properly designed basins of this type from 50 to 75 per cent of the suspended matters may be removed and deposited as sludge at the bottom. The remaining 25 to 50 per cent will ordinarily not settle from the sewage in a very extended period, and therefore the prolongation of the period of storage beyond, say, twelve hours is economically inadvisable. The volume of sludge accumulating in American tanks seems to be from 4 to 6 cubic yards per million gallons of sewage treated. This process, while relieving the sewage of a substantial proportion of suspended solids, nevertheless affords in itself no method of disposal of the sludge as does, in a degree, the septic process. The sludge must be removed from the tanks at frequent intervals and must be separately treated. Under the conditions where plain subsidence would be used, it is evident that the sludge can not be disposed of in currents of water because, if this were a possibility, the crude sewage could be disposed of in the same manner without treatment.

Reviewing California conditions, the writer believes that there are but few situations where plain subsidence can be satisfactorily utilized as a process of sewage treatment. These would seem to be—

(1) In connection with disposal by dilution in tidal waters capable of receiving the settled sewage without producing a nuisance, and where the sludge can be taken to sea in vessels, as at Manchester and London, England.

(2) In connection with intermittent sand filtration and sewage farming where areas of fairly coarse material, suitable for sludge beds, are available.

(4) *Sewage straining or roughing.*

Only a few examples of roughing filters for sewage exist in this country or Europe. When provided it is with the object, of course, of removing the suspended matters by means of rapid straining. This is done either through beds of coke or through sand beds in filters constructed like the rapid sand or mechanical water filter. Coke beds have not proved successful in actual practice, especially in cold climates. Rapid sand filters produce a volume of wash water, highly charged with the organic or mineral impurities of the sewage, which may amount to from 3 to 10 per cent of the filtrate. Such wash water requires special treatment which is ordinarily very difficult and expensive. No coagulant is used in connection with such straining filters. The process is an expensive one at the best, both as respects construction and operation. The effluent from such works can be made fully equal to, if not better than, the effluent of plain sedimentation basins, from a sanitary point of view. It is believed that this is not an available process under most California conditions.

(5) *Chemical precipitation.*

The subsidence in basins of suspended solids, by the use of coagulants of various kinds, was an exceedingly popular method of sewage treatment during a period of some twenty to thirty years prior to the introduction of the so-called biological processes about twelve years ago. A very large number of plants was constructed in England during this time, and a few plants were built in America. By the use of chemicals it was attempted to produce at least a clear effluent, free from suspended matters. This was quite possible, but the sludge problem was rendered even more difficult to solve, and the effluent, while clearer, was scarcely less putrescible than that resulting from plain subsidence. The amount of sludge created by this process is ordinarily fully fifty per cent greater than with plain subsidence. The efficiency of the removal of suspended matters has usually ranged from sixty to ninety-five per cent. This process is primarily available in California only under the conditions first stated above as the field of application of plain subsidence, namely, in connection with disposal by dilution in situations where the sludge can be taken to sea in vessels.

(6) *The septic process.*

(*a*) *Cameron type septic tanks.* The characteristic processes involved in the action of septic tanks are not at all different from those which have for a long time been relied upon in connection with the disposal of sewage in leaching cesspools, though, perhaps, without recognition and study until the development of the septic tank called attention to them and offered an explanation for the well-known fact that the sludge from domestic wastes accumulated very slowly, if at all, in such chambers. As a definite treatment, adapted to municipal sewages, the septic process dates back some sixteen years. It was then exploited by Donald Cameron of Exeter, England, who achieved remarkable success in the anaerobic (decomposition) treatment of a portion of the sewage of that city. In his experimental tanks the sludge accumulated very slowly and was so thoroughly changed in composition, due to the long continued action of the bacteria (and other organisms), that it became like humus, and in one year amounted to perhaps one fifth, only, of the solids deposited in the tank. The effluent contained about seventy per cent of the organic matter in the raw sewage. These results were so remarkable as to attract the widest attention, and similar experiments were inaugurated in many different places with corresponding success. On the basis of these studies, the septic process was adopted for the treatment of municipal sewage with almost hysterical enthusiasm, not only in England, but on the continent of Europe and in America. In America, especially, the septic tank wave rolled from the Atlantic to the Pacific seaboards, leaving in its wake a huge number and variety of septic tanks. Some of these, well designed and adapted to local conditions, have achieved all that could reasonably be expected of them, but many others have absolutely failed to perform the work which early experiments would indicate as possible. Failures have been due to a variety of causes, perhaps more than any others to ill adaptation to the specific conditions met with in specific cases, and to a general ignorance of the true principles involved in anaerobic sewage treatment. That the process during the past ten years has been over-exploited and that its general efficiency has been greatly exaggerated are apparent to-day, when, in view of many failures, an actual distrust of the process has been brought about. The statement has been widely circulated among laymen that the effluent of septic tanks is quite suitable for drinking purposes, all of the impurities of the sewage being removed thereby. During the past few years the writer has received many inquiries regarding the truth of this statement.

The septic tank process is primarily aimed at the removal of sludge. It is by no means a final process, inasmuch as the effluent is almost invariably somewhat turbid, always extremely putrescible and rich in unstable dissolved organic matter.

A review of the principles and results of operation of the septic tank of the Cameron type would appear to justify the following more important conclusions:

(1) The average removal of suspended solids from the raw sewage by the most successful tanks may vary between thirty-five and eighty-five per cent, averaging perhaps fifty to sixty per cent. At times of active gas formation the septic effluent may contain a larger amount of suspended matter than the entering sewage. As the sludge accumulates in the tank the condition of the effluent, as respects turbidity and suspended matter, is apt to gradually become less satisfactory.

(2) In some tanks the gassification and liquefaction of sludge almost keeps pace with the rate of accumulation, so that a period of several years may elapse between enforced cleanings. In many other cases the tanks require frequent cleaning, say from two to twelve times per year. The volume of sludge digested, *i. e.*, liquefied and gassified, would seem to ordinarily vary between ten and sixty per cent. The average value is certainly not over forty per cent. Septic sludge is normally less offensive than the sludge from plain sedimentation or chemical precipitation tanks.

(3) The period of storage in septic tanks must be carefully adjusted to conditions. Weak sewages seem to require a shorter storage period than strong sewages. Moreover, the condition of the sewage, whether fresh or comparatively stale when delivered to the tank, is a controlling factor. The gross capacities of the tanks which have been apparently well designed and which have operated with more or less success have been equivalent to from eight to forty-eight hours of sewage flow. As a rule, the period should not be greater than twenty-four hours nor less than twelve hours, except possibly with weak or stale sewages. Multiple units are very desirable in order that the storage period may be controlled to give optimum results.

(4) As compared with fresh settled sewage the septic effluent, especially that resulting from a too-long storage in the tank, is probably more difficult to oxidize in final processes of sewage treatment, such as the trickling filter, contact bed, intermittent sand filter or sewage farm.

(5) The septic process does not seem to afford an efficient means of destruction of pathogenic bacteria. Recent investigations would seem to permit of the conclusion that septic effluents are only less dangerous than crude sewage to the extent of the efficiency of removal of organic matter.

(6) The climatic conditions in California are especially favorable to the septic process and, in fact, to all biological processes of sewage treatment.

It must be recognized that the septic tank, like other engineering works of this nature, can not be a standardized apparatus. It is one which must be carefully proportioned, designed and adapted to the governing conditions of each case. Probably special consideration must be given to details of design in those sections of the State where very high summer temperatures prevail. Matters of design are beyond the scope of this paper.

Federal patents on the septic tank process have been granted to the Cameron Septic Tank Company, and all cities, towns, and institutions in the United States which have constructed septic tanks have been warned of infringement and threatened with suits. The status of this litigation is so familiar to the people of California that further reference to this subject is considered unnecessary here.*

(*b*) *Imhoff type tanks.* In recent years very many investigations and experiments, looking to a more successful solution of the sludge problem than is offered by the septic tank, have been under way. In consequence, various schools of workers, holding different views of the problem, have developed. Some of these schools believe that successful sewage treatment is primarily a physical process involving sedimentation and surface contact, while others hold that the bio-chemical actions are of extreme, if not of fundamental, importance. As a matter of fact, there is truth in both points of view; and it is to be expected that in the future the relative value of sedimentation and surface contact, of bacterial action, and of the activities of larger organisms, such as worms, arachnida, etc., will become manifest.

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*The full details of this litigation in California have been previously published in the March, 1910, number of this Bulletin.

Aside from its lack of efficiency in many cases, objections to the Cameron type septic tank have been raised on the ground that the effluent is too stale and difficult to treat by oxidation processes, that the odor is frequently obnoxious, and that the sludge is not thoroughly digested and is sometimes quite offensive, although, as stated above, not generally so offensive as that from plain and coagulated subsidence.

During the past two or three years there has been developed in the Emscher Valley, in Germany, a type of tank which seems to overcome most, if not all, of the principal objections to the Cameron type of septic tank. This process was suggested by Dr. Imhoff, and has been strongly advocated by the Emscher Drainage Board. The tank is variously known as the Emscher, Ems, Essen, and Imhoff tank.

In brief, the process consists in passing the sewage at a low velocity through comparatively shallow V-shaped tanks, or chambers, whose sides are sufficiently steep so that the deposited solids settle to the bottom of the V, where they pass through suitably arranged slots into a deep chamber below. The period of storage of the main bulk of the sewage is comparatively brief, say two to four hours. The period is so short that septic action does not become established, yet the rate of travel is sufficiently slow so that a substantial proportion of the suspended matter is deposited. The sewage may then be passed to other treatment devices or to points of discharge in watercourses, as the case may be. It will be seen that the sewage does not have a chance to become stale in the tanks nor does it come in contact with decomposing sludge.

In the lower tank, into which the sludge settles through the slots above referred to, a slow digestion takes place through septic and other action. At frequent intervals portions of the thoroughly digested sludge are drawn off from the bottom of the tank by special piping arrangements and fresher sludge takes its place. The sludge, thoroughly rotted by the action of the bacteria, worms, etc., is no longer sticky and greasy, but humus-like. Due to the downward motion of the sludge, caused by drawing off small quantities at frequent intervals, any toxines which may be produced locally by bacterial action, and which would tend to inhibit such action, are apparently distributed and diffused so that bacterial activity is maintained and the maximum amount of solids is liquefied or gassified. The gas is taken from the top of the lower tank through specially arranged pipes or openings. The sludge is either discharged upon special sludge beds of coarse material, where in favorable weather it drains quickly and soon reaches a state permitting of easy removal, or it may be buried in trenches in agricultural land.

The efficiency of this process under American conditions can only be inferred from certain experimental results. The results obtained at Philadelphia during one year of operation of experimental tanks have been very satisfactory. Tanks of this type have been recommended by Messrs. Hering and Fuller of New York City, and are about to be installed for the treatment of the sewage of Atlanta, Ga.

The California climate would undoubtedly be very favorable to this process. In general, this method of treatment promises well, and should be investigated under local conditions. In a short while considerable data for American sewages will be available. It is evident that the proportioning of these tanks, both with relation to the period of storage of the sewage to effect a deposition of the solids and of the sludge to bring about thorough digestion, is a matter of great importance and must be worked out for various climatic conditions as well as different sewages.

The septic process, as carried out either in the Cameron type or in the Emscher type of tank, but especially in the latter, has at present two distinct fields of usefulness: first, it constitutes an effective means of preparation for any final process which can be better conducted with a sewage from which the suspended solids are more or less completely removed; second, it may be employed where disposal by dilution is permissible if the source of unsightly sludge and scum is removed.

(7) *Contact beds, single.*

All of the methods or processes of treatment which have been previously discussed have been aimed primarily at the separation from the sewage of the suspended matters, from the coarsest to the very finely divided. Only secondarily have chemical changes in the liquid portion of the sewage been intentionally brought about. In contact beds, however, we have a process which not only removes or changes the character of the suspended solids but which purifies the sewage by bio-chemical action. The action is both anaerobic (liquefying and gassifying) and aerobic (oxidizing), principally the latter. The process, in its physical, chemical and biological actions, is exceedingly complex, although the works required for carrying it out are extremely simple.

Briefly stated, a contact bed comprises a water-tight basin from three to four feet in depth, filled with some hard and fairly durable granular material of a uniform size suited to the particular requirements of a given case, or with horizontal layers of slates or slabs laid about two inches apart. Contact beds must be thoroughly underdrained and the distribution of sewage over the surface must be such as to prevent local clogging.

As usually operated, the beds are filled with sewage in from one to two hours, are kept full of sewage from two to three hours, are emptied in from one to two hours, and remain empty for from four to six hours. Of course, deviations from this general regimen are frequent. The rate of operation of single contact beds is generally equivalent to not less than 600,000 gallons per acre per day, and is seldom greater than 1,000,000 gallons. The loss of head is seldom less than four feet nor more than six feet with beds of the depths stated above.

Single contact, *i. e.*, the use of a single set of contact beds, does not usually produce a stable effluent and, therefore, is to be regarded as a preliminary process in accordance with the distinction adopted for the purposes of the present discussion. The purification which may be expected from single contact, as measured by the removal of suspended solids, may vary between sixty and seventy-five per cent, and as measured by the removal of organic matter between fifty and sixty per cent.

Single contact is seldom employed as a preparatory treatment; it is occasionally employed in conjunction with septic tanks or other preparatory treatments as a final process. Such plants are in operation at

Plainfield, N. J., and Mansfield, Ohio, and are said to be giving satisfactory results. California climatic conditions are favorable to this process, and there are doubtless some circumstances under which it can be used to advantage. As a general statement, it may be said that the septic process, perhaps especially as conducted in the Emscher tank, is cheaper and gives an almost equally effective preparatory treatment, yielding a greatly improved but putrescible effluent. Although sometimes employed as a final method of treatment, as stated above, it does not appear that contact beds have a great field of usefulness for this purpose. As respects the destruction of pathogenic bacteria, it is believed that contact beds are not more efficient than other processes giving the same efficiency in the removal of organic matter.

(8) *Contact beds, double.*

Double contact implies the operation of two sets of contact beds arranged in tandem. As a rule, the material in the beds utilized for the second contact is considerably finer than in the first. The process is capable of yielding a non-putrescible effluent, low in suspended matters though somewhat discolored, and one which can be discharged without offense into very small streams. The net rate of operation, referred to the total superficial area of both sets of beds, is seldom greater than 500,000 gallons per acre per day nor less than 300,000 gallons. The process is not as flexible as to rates of operation as are certain others to be later described. A head of from six to ten feet is normally required for this process. The total efficiency, as measured by the removal of suspended solids, has been found to vary from eighty to nearly one hundred per cent; as measured by the removal of organic matter, the efficiency usually ranges between seventy and eighty-five per cent. One very unfavorable feature of contact beds is that they gradually become clogged with resistant organic and mineral matter, so that removal and cleaning of the filling material are required. This is, of course, expensive and is especially undesirable where labor costs are high.

Climatic conditions in California are favorable to this process. It is capable of treating crude sewage, especially that from which the coarser suspended matters have been removed by effective screening. As compared with intermittent sand filters or sewage farming, from the standpoint of efficiency, the process yields distinctly inferior results. As compared with percolating or trickling beds, contact beds are less compact and are more costly. They are, however, less conspicuous, the odor attending the process is less pronounced and they do not breed flies as trickling filters are reported to do. This process may have a field of usefulness in special cases under California conditions.

(9) *Trickling, percolating, or sprinkling filters or beds.*

Trickling or percolating filters have been gradually evolved through experiments conducted during the past twenty years. For ten years the process has been in practical operation and for four or five years the mode of action has been fairly well understood, and the process has been a demonstrated success under conditions to which it is adapted and where the works have been properly designed. These filters consist essentially of beds of coarse-grained, durable material resting upon some efficient system of underdrains in or on an impervious floor. If above ground, the beds may be surrounded by walls of concrete, by open brick work or by banked-up filling material; if in excavation, the side walls may be vertical, of concrete, brick or stone, or sloped at the angle of repose of earth and paved or concreted. The size of material, the depth of bed and the rate of operation are all interdependent factors and all relate closely to the strength and character of the sewage. It is of fundamental importance that the sewage be sprinkled or deposited on the surface of the beds in thin, thoroughly aerated films. In practice, the depth of bed generally ranges between 4 and 6 feet, the size of material from $\frac{1}{8}$ of an inch or $\frac{1}{2}$ of an inch up to $1\frac{1}{4}$ inch or 4 inches, and the rate of operation from perhaps 1.0 to 2.5 million gallons per acre. The loss of head is rarely less than 8 feet, and it may be considerably more. It is to be observed that these rates of operation are far in excess of any that can be obtained with other final processes of sewage treatment, especially with intermittent sand filters and broad irrigation. Generally speaking, the best results are not secured with the application of crude sewage unless it is especially weak and has been thoroughly screened, but rather with sewages from which a substantial percentage of suspended matter has been removed by preparatory treatment.

This process is wholly one of oxidation, in which absorption, bacterial action and the activities of larger organisms all play a conspicuous part. The effluent of properly designed and operated works is non-putrescible or stable in character, and may be discharged into the smallest streams. The effluent is not clear, but contains humus-like particles which settle rapidly and which in weight are practically equivalent to the weight of solids applied to the filter. In other words, the trickling bed does not accumulate solids as does the contact bed. As measured by the reduction of organic matter, the general efficiency of the process has ranged in England between eighty and ninety-five per cent. In the United States a much lower efficiency has been obtained, both in experimental and in large municipal plants. Nevertheless, the effluent in all cases has generally been stable and thoroughly suitable, after the settlement of suspended matters, to discharge into streams. In respect to the removal of organic matter, this process shows decided superiority over the double contact process.

In California the conditions are generally ideal for this process. It should have a wide field of usefulness, wherever compact plants must be erected to operate at comparatively high rates in more or less thickly settled districts, where sufficient head is available by gravity or pumping and where land would not be available or the conditions right for broad irrigation or sewage farming.

(10) *Intermittent sand filtration.*

Intermittent sand filtration is by far the best known and most thoroughly studied process of sewage treatment in America. For more than twenty years it has been constantly under investigation by the Massachusetts State Board of Health, both in experimental plants and in municipal plants, on a large scale. Many sewage purification plants of this type are in operation in Massachusetts, Ohio, and other states where suitable materials are naturally available. The process is one of nitrification or oxidation, and seems, in a general way, to epitomize the natural purification which the soil effects of all impurities deposited in a film thereon. As usually carried out, areas of suitably porous soil are selected and the top soil is removed and placed in embankments between beds, making these of a size best adapted to the rate of sewage flow. These beds are underdrained with tiles if the water-table is not naturally low. Where suitable material is not found *in situ*, the beds may be constructed of especially selected and deposited materials, but such construction, of course, increases the cost greatly. In operation, the sewage is applied in rotation rapidly to each bed until each is completely covered to a slight depth. The bed is then allowed to drain slowly and to rest for some time thereafter. Meanwhile, other beds are being dosed, drained and allowed to rest. These filters are very sensitive to long-continued overdosing and to lack of aeration, and will not prove efficient if not carefully dosed, cleaned and rested. A great deal of information is available with reference to these matters, and it is considered entirely unnecessary to refer in detail to them here.

If conducted in suitable soils at proper rates very high efficiency may be obtained with intermittent sand filters. At one plant, at least, in the United States, that at Spencer, Massachusetts, the filter attendant regularly uses the effluent as a drinking water supply. The bacterial purification should be fully 99 per cent under favorable conditions. The removal of organic matter should be fully 95 per cent. The effluent is usually of excellent appearance and free from disagreeable odors. The rate of operation varies very widely, according to the character of applied sewage, the porosity of the soil, the temperature conditions, etc. In general, the rate varies between 40,000 and 100,000 gallons per acre per day. Higher rates may be employed with effluents of efficient preparatory treatment works.

It is not probable that this method of treatment will ever find wide application in California, although here, as for other biological processes, the climate is quite ideal, even in the most elevated districts where such plants would in all likelihood be built. Where gravelly or sandy deposits are to be found and where broad irrigation can not be conveniently resorted to, as for small isolated institutions, hotels, summer resorts, camps, etc., this method of purification could be very advantageously employed. Throughout our mountainous districts are many resorts where this method of treatment could be very easily adopted, thereby protecting in an efficient manner the streams which are now being polluted.

(11) *Broad irrigation or sewage farming.*

In the process of treatment known as broad irrigation or sewage farming the sewage is utilized for the growth of crops in very much the same manner that water would be. The sewage has, however, some slight fertilizing value. In principle this method is not essentially different from intermittent sand filtration, but it is usually conducted at rates from one tenth to one twentieth as great as those employed with intermittent sand filters. It is possible to dispose of sewage by broad irrigation at rates varying from 2,000 to 10,000 gallons per acre per day, depending upon the character of the sewage, the kind of preparatory treatment which it has received and the character of the soil. As with intermittent sand filters, higher rates of dosing and better results are generally to be obtained with sewages from which the suspended matters have been in part removed by some preliminary treatment. Heavy soils are not naturally adapted to this method of sewage treatment, but they can be utilized if sufficient area is provided so that the rate of application shall be suitably low. The efficiency of treatment, measured by the removal of suspended solids, organic matter and bacteria may, under favorable conditions, be very high indeed, perhaps fully as high as with intermittent sand filtration, which yields effluents of greater purity than any other method thus far discussed. In England an extended experience with broad irrigation shows that if the land is naturally unsuited to this treatment, and if the rate of application is too great or the farms improperly manipulated, high efficiencies can not be obtained. In France and Germany very satisfactory results have been obtained on the extremely large sewage farms operating on the sewage from the cities of Paris and Berlin, respectively. Few, if any, data showing the efficiency of sewage farming in the United States are availagle.

There can be no question but that in an arid or semi-arid district, where soil conditions are suitable and where lands are available, the disposal of sewage by irrigation is the most logical method which can be employed. It would seem to be a criminal waste to discharge sewage into streams or into the ocean when adjacent lands are suffering from lack of moisture. Moreover, the pollution of the streams whose purity would otherwise be preserved is a feature worthy of careful consideration.

In the rainy season it is specially important that sewage farming be carefully conducted, in order that the sewage shall be thoroughly purified and at the same time that the land shall not be super-saturated. It must be impressed upon the municipalities utilizing this method of sewage treatment that sanitary efficiency rather than financial success is to be primarily sought.

In California the sewage of a number of communities is being successfully treated by broad irrigation, both on municipally owned and on privately owned areas. At some places, notably Fresno, considerable competition in securing rights to the use of sewage for irrigation has developed on the part of private landholders.

(12) *Disinfection of sewage or effluents from sewage treatment works.*

During the past few years a great deal of attention has been devoted to the problem of the treatment of water and sewage to effect the removal of bacterial contamination, especially contamination by disease germs. Various sterilizing or disinfecting agents have been investigated, with the result that all have been found either too difficult or too costly to apply, with the exception of certain salts of copper and certain chlorine compounds. Of these, for most conditions, the hypochlorite of calcium (bleaching powder) has been found to be cheapest and most efficient, although sodium hypochlorite, electrolytically prepared, may be favorable in very large plants under expert supervision in localities where electric power is very cheap. Carefully conducted experiments at various places have demonstrated clearly that the great bulk of dangerous bacteria can be removed from crude sewage or effluents from sewage treatment works at a very moderate expense, especially for the latter. It is scarcely to be expected that disinfection will be found necessary for effluents from intermittent sand filters or sewage farms, where the bacterial efficiency is already very high. But where effluents from preparatory treatment or rapidly-operated final treatment works, such as contact beds and trickling filters, are discharged into watercourses from which water supplies are derived, or into tidal estuaries from which shellfish are being taken for the markets, it appears that disinfection has a distinct field of usefulness. It is apparent that disinfection is especially necessary when epidemics of intestinal, water-borne diseases prevail in any community disposing of its partially purified or crude sewage in streams utilized for water supply purposes.

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SEPTIC TANKS.

By N. D. Baker, Junior Member American Society of Civil Engineers.

PURPOSE.

The septic process is used for three reasons:

1. To get the sludge or solids out of the sewage so that the liquid part of it may be disposed of by some other means. If this is to be done by broad irrigation or by filteration through sand beds it is essential that the sludge be taken out first to prevent clogging of the distributing ditches or of the filters, as the case may be. The sludge might be removed by plain sedimentation, chemical precipitation, or to some extent by screening, but this leads up to the second purpose of the septic tank; which is—

2. To destroy the sludge. In using any of the other three methods of sludge removal, the great question of sludge *disposal* remains unsolved. The sludge has been taken out but not destroyed. The properly operated septic tank removes a considerable portion of the sludge and also destroys or "digests" a considerable portion.

3. Another purpose of the septic process is to carry the sewage through

the first stages of putrefaction, and to render it less likely to create a nuisance when discharged into streams or other bodies of water or on land. It has been estimated that a stream will receive twice as much septic sewage as it will take raw sewage before the point of pollution is reached which will cause a nuisance.

THEORY OF A SEPTIC TANK.

The septic process differs from others in that here the organic matter in the solids is broken down to simpler substances by the putrefactive or liquefying bacteria. These low forms of vegetable life work best in absence of air, and they use up the dissolved oxygen in the sewage so that the action, if complete, would give an effluent which would contain *no* dissolved oxygen. After these (anaerobic) bacteria have done their work, the sewage needs to have oxygen introduced so that the (aerobic) oxygen-using bacteria may perform their work of oxidization. It is by the activity of these aerobic or nitrifying bacteria that the products of anaerobic action are oxidized and the resulting condition of the sewage rendered stable, *i. e.,* incapable of further putrefaction.

DESIGN AND OPERATION.

Probably in no other branch of engineering work is there a wider range of variation than in the design of septic tanks. The chief objects of design should be: to get a sufficiently long storage of the sewage to complete the septic action and still not have it too long; and to enforce a uniformly slow and diffused flow through the tank so that there will be no parts of it where the sewage remains stagnant. Also to properly proportion the tank so that the surface area shall be sufficient for mat formation. In some tanks series of baffles are introduced to insure uniform flow. In some of these the baffles are vertical, let down from the top and built up from the bottom, while in others the baffles extend into the tank from the sides. Experience indicates that the use of baffles elsewhere than at the extreme end of the tanks is not to be encouraged.

Size.—The size should be sufficient to hold the flow for the period of storage desired. In different designs this varies from twelve to forty-eight hours. Perhaps eighteen hours' flow is a good average to use, but the period of storage should be adapted to the condition and character of the sewage. Many of the tanks now in use are rectangular, but there have also been designs made for circular tanks in which the sewage is taken in at the center and discharged around the circumference. (Ref., Engineering Record, vol. 60, page 249.)

Area.—Heretofore this point has not been emphasized, but it is important that there be sufficient area for mat formation. This varies with the total solids in the sewage, and also directly with the number of persons connected with the system. If the area is not sufficient, as might be the case where the flow per capita is small, there will be a continued accumulation of sludge until it gets so thick that the tank has to be cleaned and started again. In tanks of this kind one of the purposes of the septic tank is defeated, for the tank only removes the sludge and does not destroy it. In tanks of good design the surface area varies from one half to one square foot or more per person. The first figure is hardly large enough.

Roofs.—The question of roofing a septic tank has aroused some discussion. On the one hand it is claimed that since it is a bacterial process and since bacteria develop and work best in the dark, a roof is necessary to shut out the light. Against this it may be said that after the "mat" is formed on the tank it shuts out the light as effectually as a roof. Again, some engineers think an air-tight roof or covering is essential to foster the anaerobic bacterial action. The same answer is applicable here as was given above; that the mat, once formed, is a seal against air as well as light. In fact, there are many successful tanks which are not tightly covered. The best argument in favor of roofs is that the wind tends to break up the mat and prevent its formation in the early stages.

Aeration.—Because the action inside the tank is essentially an anaerobic one, the inflow should be so arranged that as little air as possible is carried in with the sewage. At the outflow pipes provision ought to be made for aerating the effluent. This may be done by making it pass over weirs in thin sheets, or pass upward through vertical pipes and over the edges, falling in a circular sheet. Other devices are used—throwing the sewage through the air in a spray and pumping air through it.

WHAT SHOULD AND SHOULD NOT BE EXPECTED OF A SEPTIC TANK.

A properly designed and operated septic tank should give an effluent containing very little solid matter in suspension, and that only in finely divided particles. Unfortunately this idea is seldom realized. The effluent will still be putrescible and offensive, and may (and very likely will) cause to some extent a nuisance unless properly handled while being further purified.

The bacterial action should destroy all but the mineral ash of the sludge, and the tank ought not to have to be cleaned oftener than once in several tanks. Here again the idea is frequently far from realized. Tanks cleaned every month can certainly not be considered successful.

The mat forms on the surface after a week or more and becomes thicker until the tank reaches a condition of equilibrium. The mat is usually 12 to 18 inches thick at this time, although one case was called to my attention where it continued to grow until it occupied a large proportion of the tank and had to be removed. This was an instance of too small a surface area.

The septic process is only a *preliminary* treatment and can be regarded as nothing more. The effluent is not stable. There is little evidence to prove that pathogenic bacteria do not survive the septic process in sufficient numbers to render the effluent dangerous without further treatment; in fact, there is every reason to believe that such effluents are distinctly dangerous from the standpoint of infection with disease germs.

Limitations.—In applying the septic process of sewage disposal to industrial wastes, each particular problem must be considered by itself. It is largely a problem for the chemist to determine what the sewage contains and what effect, if any, it will have on bacterial action. Through the Santa Clara and San Joaquin valleys the cannery wastes present a special problem. Sometimes these contain large quantities of lye used for peeling fruit. It is probable that this lye would act as a disinfectant in the sewage and deter or entirely prevent septic action in the tanks. At other places there are winery wastes and wastes from tanneries, dye works, pickle factories, paper mills, iron foundries, woolen mills and other establishments, each of which presents its own particular problem and must be dealt with accordingly. Very often it is more desirable to keep such wastes out of the main sewers and dispose of them independently.

Another point of note is that to lend itself readily to septic treatment, sewage should not be too dilute. In any method of treatment it is only economy to treat as small a quantity as possible, since septic treatment depends on bacterial growth in the sewage.

Wherever septic disposal is used the storm drains ought to be in a separate system from the domestic sewers. Sometimes it is desirable to let the first "run-off" from the streets after a "dry spell" go into the domestic sewers for purification treatment, for it sometimes carries considerable organic matter, but after the streets are washed clean this should no longer be done. In some cities this is provided for by connections between the storm drains and domestic sewer mains which are opened for a short time when rain begins to fall. If such practice obtains, the tanks should be especially designed and operated to meet such conditions.

TREATMENT OF SEPTIC EFFLUENT.

To complete the purification of sewage, the effluent of septic tanks must be subjected to a final process in which the nitrifying or aerobic bacteria oxidize the products of the anaerobic action.

Sometimes this can be done at a profit by using the water for irrigation. For reasons that will be apparent it ought not be used for berries and soft skinned fruits nor for vegetables, such as celery, radishes, lettuce and those that are to be eaten raw. Where space is too limited for disposal by irrigation, contact beds or sprinkling filters are sometimes made use of. The materials used are broken stone, brick, coke, cinders, etc., the idea being to have a large area exposed to the sewage. The beds are filled and drained alternately at intervals of eight to twelve hours. During the period when the filter is empty cultures of aerobes develop on the surface, oxidizing the material left there from the sewage. The purification depends on a bacterial process and the action is that of both aerobic and anaerobic forms which oxidize the organic matter and render it non-putrescible. These filters need not be expensive. They require some attention but various patent automatic devices for regulating them are in use which serve to minimize the work of running the filter as well as to remove the personal equation of the attendant.

The use of slate beds is attracting some attention. These are made up of horizontal slabs of slate held apart at the ends by stone blocks. For the slate beds it is claimed that worms develop on the slates which work over the sludge and reduce it to harmless and inoffensive humus. The slate beds, like the contact filters, are dosed and rested alternately, multiple beds being necessary for this reason. A very good account of slate beds can be found in the Engineering Record, vol. 60, page 511.

Data on Some California Septic Tanks.

Fresno.—Population (1910), 24,900. Average sewage flow 6 to 7 cubic feet per second; 4,000,000 gallons per day. Concrete tanks; eight tanks each 36 by 90 by 6½ feet. Total capacity, 1,260,000 gallons. Storage about 7 hours. Effluent used for irrigation. Area surface, 26,000 square feet, or 1 square foot per person. City engineer, Mr. C. P. Jenson. Tank designed by Mr. Geo. L. Hoxie, formerly city engineer. The sludge has to be removed every few weeks.

Colusa.—Population (1910), 1,580. Reinforced concrete tanks; 2 units each 180 by 6 by 7½ feet. Total capacity, 50,000 gallons. Total area, 2,160 square feet, or 1.4 square foot per person. Designed and built by Mr. J. W. Kearth, city engineer.

Selma.—Population (1910), 1,750. One concrete tank, 40 by 100 by 8 feet. Capacity, 240,000 gallons. Area, 4,000 square feet, or 1.6 square feet per person. Estimated storage, 24 hours. Designed and built by Mr. Schaffer, city engineer.

Hanford.—Population (1910), 4,830. Tank designed by Dr. Musgrave, City Health Officer. Timber lined tank 65 by 24 by 7 feet. Capacity, 80,000 gallons. Area, 1,560 square feet, or .26 square foot per person. Estimated storage, 5 to 8 hours. Septic action incomplete. Effluent carries solid particles Used for irrigation.

Corning.—Small private tank owned by Hotel Maywood.

Eldridge.—Population, 1,000. Wooden tank 150 by 15 by 10 feet, covered. Capacity, 155,000 gallons. Area, 2,250 square feet, or 2¼ square feet per person. *Storage, estimated 24 hours. Effluent very clear, but rather offensive.

Willows.—Population (1910), 1,140. Settling tank of concrete, open, 33 by 10 by 10 feet, designed for sedimentation; depth of 2½ feet. Capacity, 6,200 gallons. Area, 330 square feet, or .16 square foot per person. Not designed for septic treatment. Effluent clear and free from solids. Used for 3 years, and very small sludge deposit.

Sebastopol.—Population (1910), 1,230. Timber lined tank 160 by 15 by 6 feet, covered. Capacity, 100,000 gallons. Area, 2,400 square feet, or 1.6 square foot per person. Storage, estimated 10 to 15 hours.

Santa Rosa.—Population (1910), 7,820. Roofed, unlined tank, 250 by 27 feet at surface, 8 feet deep; side slopes 1 to 1. Capacity, 300,000 gallons. Area, 6,750 square feet, or 1.1 square feet per person. Estimated storage, 4 hours. Septic action incomplete.

Bakersfield.—Population (1910), 12,700. City engineer, Mr. Buffington. Circular concrete tank designed by Mr. Buffington, 200 feet diameter, 8 feet deep. Capacity, storage, 16 hours.

Redondo Beach.—Population (1910), 2,940. City engineer, Mr. A. A. Henderson. Septic tank designed by Olmstead and Gillelen, Wright and Callender Building, Los Angeles. Tank 160 by 50 by 7½ feet; reinforced concrete arched roof. Capacity, 450,000 gallons.

Long Beach.—Population (1910), 17,800. Timber lined tank, two units, each 610 by 6 by 6 feet. Capacity, 44,000 cubic feet—330,000 gallons. Area of surface, 7,300 square feet, or .37 square foot per person.

Sawtelle, Soldiers' Home.—Total population, 3,000. Two tanks, independent, but same size and same flow. Each tank 70 by 20 by 8 feet. Capacity, each 82,500 gallons. Total capacity, 165,000 gallons. Estimated storage 6 hours. Area of surface (total for both) 2,800 square feet, or .9 square foot per person. Tanks doing good work.

Pomona.—Population (1910), 10,200. Tank 45 by 24 by 8 feet, cement lined. Capacity, 65,000 gallons. Flow estimated at 75 gallons per capita, 750,000 gallons. Estimated storage about 2 or 3 hours. Area, 1,100 square feet, or .1 square foot per person. Tank too small, and has to have mat removed frequently.

Patton State Hospital.—About 1,500 inmates. Concrete septic tank. Two units; only one in use. Each unit 116 by 20 by 7½ feet. Capacity, 131,000 gallons. Estimated storage 10 hours. Area of surface, 2,200 square feet, or 1.5 square feet per person.

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The Practical Operation of Sewage Purification Plants. John W. Alvord, Chicago.
Annual Reports of Massachusetts State Board of Health. 1900–08.
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Septic Tank Disposal:
  Engineering Record, vol. 60, pages 37, 249, 287, 580.
  Journal of the Association of Engineering Societies, vol. 34, page 33.
  Sewage Contact and Sprinkling Filters.
  Engineering Record, vol. 60, pages 77, 212, 351.
  Engineering News, vol. 62, page 196.
Slate Beds. Engineering Record, vol. 60, page 511.
Sludge Disposal:
  Engineering News, vol. 62, page 251.
  Municipal Engineering, vol. 37, page 20.
Septic Tank Patents:
  Municipal Engineer, vol. 35, page 290.
  Engineering Record, vol. 58, pages 223, 253.

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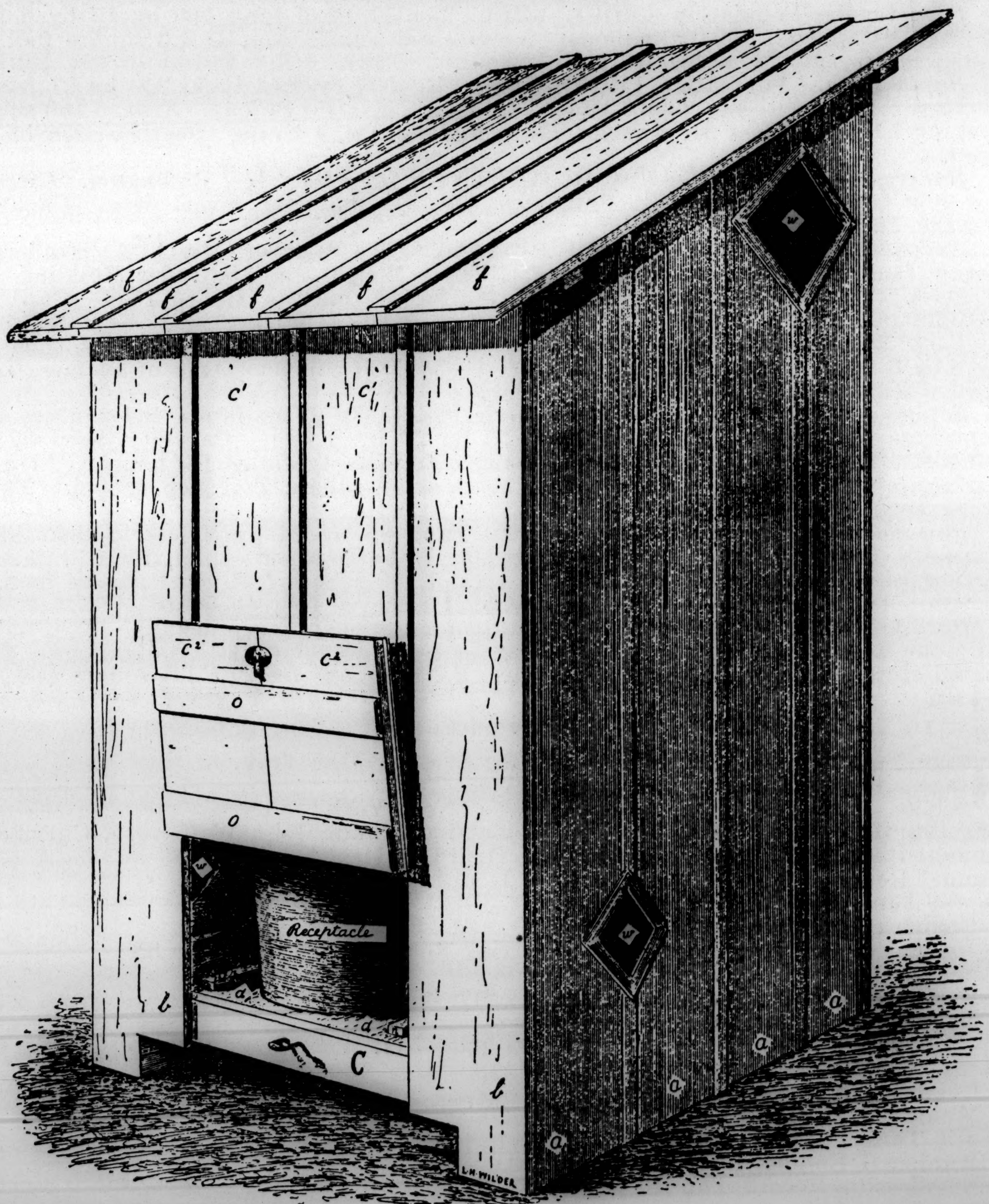
*Measured flow Oct., 1909—77,000 gallons, septic period 48 hours. Action incomplete.

Crops on Sewage Beds:
  Municipal Engineer, vol. 37, page 105.
  Engineering News, vol. 62, page 167.
Manufacturing Wastes. Engineering News, vol. 62, page 101.
Disinfection of Sewage. Municipal Engineer, vol. 37, page 364.
Sewage Disposal in America. Municipal Engineer, vol. 37, page 80.
Cost of Disposal. Municipal Engineer, vol. 37, page 106.
National and State Control. Engineering Record, vol. 60, page 704.
Sewage Disposal at Country Houses. Engineering Record, vol. 60, page 681.
Standards of Purification. Engineering Record, vol. 60, page 667.
Baltimore Sewage Disposal. Engineering Record, vol. 60, page 580.
Stream Pollution. Engineering Record, vol. 60, pages 157, 420.
Sewage Testing at Philadelphia. Engineering Record, vol. 60, page 71.
Sewage Disposal in America. Transaction Amer. Soc. C. E., vol. 54, pages 147, 182.

THE PROBLEM OF THE HOUSE WITHOUT A SEWER.

The cut below illustrates the type of sanitary privy which is being advocated throughout the Southern States.



(See California State Board of Health Bulletin, November, 1910, for complete description.)

RESIDENTIAL SEWAGE DISPOSAL PLANTS.

The following quotations from an excellent article on residential sewage disposal plants by Mr. R. Winthrop Pratt* have been included as illustrating the application of the data outlined by Mr. Baker as the basis for constructing successful septic tank plants for disposing of sewage.

"A plant designed according to the above mentioned principles may be described somewhat as follows: The outflowing sewage from the house is delivered into a settling basin of sufficient size and of suitable design to afford opportunity for the sedimentation of the solid matter and the rise of the grease. This basin or tank contains a constant volume which approximately should equal one or two days' flow of sewage. The inlets and outlets should be so arranged that neither the scum at the top nor the sludge at the bottom is disturbed as the sewage passes through it. The matter deposited in the bottom of the tank becomes partially reduced and passes away in the form of liquid or gas. There will be, however, a certain accumulation which must be cleaned out occasionally, probably not oftener than once a year. The tank should be ventilated through the main soil pipe of the house in the same way in which modern sanitary sewer systems are ventilated.

The clarified liquid overflowing from this tank passes into a second one adjacent thereto, called the dosing tank. Herein is placed an automatic siphon or other controlling device which holds back the flow until the sewage has reached a certain depth, at which time the entire contents of the dosing tank are discharged very rapidly. The discharge completed, the apparatus automatically prevents further outflow until the tank becomes again full. This tank serves to apply the sewage to the filter, sub-surface disposal system, or other means for final purification, to which the capacity or "dose" must bear a certain relation in order that the sewage be properly distributed.

Such distribution is essential for the reason that, if the sewage is allowed to pass on to the filter or into the "absorption system" in the same irregular way that it leaves the house, the filtering material will be constantly saturated in places and hence become clogged and foul. In other words, the filtering material must be kept clean by allowing the air to frequently penetrate it.

The disposal of the clarified sewage by open filters and by broad irrigation is identical, in principle, with the corresponding methods for city plants and need not be described here. Of course, these can be used only where ample land is available; and they are not suitable for built-up districts, but rather for isolated houses. In any case, these methods involve exposing the unpurified sewage to the air and are therefore less desirable than a sub-surface system. If, however, one wishes to construct a filter bed in a concrete chamber beneath the ground, this can be satisfactorily done, though somewhat expensive, in close proximity to residences.

The sub-surface disposal system is composed of lines of three-, four- or six-inch agricultural drain tile or vitrified pipe with open joints, laid level or nearly so, within one or two feet of the surface of the ground. These are called absorption or distribution pipes. Their total length is determined primarily by the porosity of the soil in which they are placed and varies for a family of five or six, from 100 to 600 feet. In clayey soils it is necessary to thoroughly underdrain the land at a depth of 3 or 4 feet in order to render the soil dry enough to absorb the sewage, and in addition it is desirable to surround the tile with gravel, cinders or porous material. There should be, of course, no opportunity for sewage to pass directly from the absorption pipe into any of the underdrains. As mentioned above, the cubical contents of the absorption system should have a certain relation to the dosing tank in order that the sewage may be properly distributed. It is often convenient, furthermore, to divide the system into two or three portions in order that the flow may be changed from one to the other every few weeks.

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*Copied without the illustrations from pp. 231-235 of the July, 1911, issue of the Monthly Bulletin, Ohio State Board of Health. Mr. R. Winthrop Pratt is Chief Engineer, Ohio State Board of Health.

There will doubtless be a certain accumulation of finely divided solid matter in the tile which may make necessary their relaying after a period of years. This, however, is a matter of small importance. The system can be placed at any convenient point and is often installed underneath the lawn or vegetable garden without in any way showing evidences of its existence, except by assisting in the growth of vegetation.

While the general principles of the design of municipal sewage purification plants apply also to residential plants, yet there are several practical differences which should be borne in mind.

In the first place the sewage from individual houses is extremely fresh and there is no opportunity for the mechanical breaking up of the larger suspended particles as is the case when sewage flows for miles in a city sewer. Then there are extreme fluctations in the rate of flow in the case of the single house, as compared to the more regular discharge from a municipality. For instance, there is rarely any flow during the night, and the flow during the day comes in sudden rushes.

The small actual size of a house sewage tank, although it may be large from the standpoint of "hours of storage," may permit a sudden inrush of sewage to stir up the entire contents, thus carrying out some solid matter and causing the filters or the sub-surface system to clog. The above mentioned facts show the necessity of designing both tanks and finishing treatment on a more liberal per capita basis than is required with municipal plants.

Finally, residential plants are intended to be more automatic than municipal plants, and rarely receive regular attention, and they must of necessity, be located much nearer to dwellings than city plants. It is necessary, therefore, to exercise much more care in design in order that no work need be done on the plant oftener than once a year, although it should be inspected every few months. Also the design should be such that the plant will create no odors even though within a few feet of a residence.

Relative to the cost of building an efficient residential sewage disposal plant for a family of five or six, this will vary greatly according to the local cost of material and labor and the character of the ground in which it is to be placed. The usual tanks with sub-surface absorption system should be built in porous ground for $100 to $150; and in clay soil for $250 to $300. A plant including a covered sand filter may cost $500."

DEPARTMENT REPORTS.

REPORT OF BUREAU OF VITAL STATISTICS FOR OCTOBER.

GEORGE D. LESLIE, Statistician.

State Totals and Annual Rates.—The following table shows for California as a whole the birth, death, and marriage totals for the current and preceding months in comparison with those for the corresponding months of last year, as well as the annual rates per 1,000 population represented by the totals for the current and preceding months. The rates are based on an estimated midyear population of 2,488,256 for California in 1911, the estimate having been made by the Census Bureau method with slight modifications.

Birth, Death and Marriage Totals, with Annual Rates per 1,000 Population for Current and Preceding Months, for California: October.

MONTH.	MONTHLY TOTAL.		Annual rate per 1,000 population. 1911.
	1911.	1910.	
October:			
Births	3,169	2,864	15.0
Deaths	2,590	2,683	12.3
Marriages	2,516	2,356	11.9
September:			
Births	2,902	2,792	14.2
Deaths	2,532	2,472	12.4
Marriages	2,446	2,223	12.0

The birth and marriage totals for October were much greater in 1911 than in 1910, while the October death total was considerably less in the present year than in the previous one.

County Totals.—The first table on the following page shows the monthly birth, death, and marriage totals for the principal counties of the State, the list being limited to counties having a population of at least 25,000 according to the Federal Census of 1910. Totals are also shown for San Francisco and the other bay counties (Alameda, Contra Costa, Marin, and San Mateo), as well as for Los Angeles and Orange counties together.

City Totals.—The second table on the following page gives the birth and death totals for the principal freeholders' charter cities, the list including all chartered cities with a census population of at least 15,000 in 1910. Totals are given likewise for San Francisco in comparison with Oakland, Alameda, and Berkeley, the three cities adjoining one another on the east shore of San Francisco Bay, as well as for Los Angeles in comparison with neighboring chartered cities (Long Beach, Pasadena, Pomona, and Santa Monica).

Birth, Death and Marriage Totals, for Principal Counties: October.

County.	OCTOBER, 1911.		
	Births.	Deaths.	Marriages.
California	3,169	2,590	2,516
Counties of more than 25,000 population (1910):			
Alameda	338	253	233
Butte	24	28	25
Contra Costa	40	29	32
Fresno	123	76	73
Humboldt	44	30	26
Kern	48	35	32
Los Angeles	816	546	625
Marin	37	5	96
Orange	27	29	102
Riverside	36	41	34
Sacramento	111	95	98
San Bernardino	67	61	51
San Diego	117	88	74
San Francisco	588	540	472
San Joaquin	65	70	53
San Mateo	20	15	37
Santa Barbara	21	28	17
Santa Clara	103	90	75
Santa Cruz	26	28	18
Solano	16	21	14
Sonoma	58	87	37
Tulare	49	18	26
Selected groups:			
San Francisco and other bay counties	1,023	842	870
Los Angeles and Orange counties	843	575	727

Birth and Death Totals, for Principal Cities: October.

City.	OCTOBER, 1911.	
	Births	Deaths.
Freeholders' charter cities	2,064	1,616
Cities of more than 15,000 population (1910):		
Alameda	37	21
Berkeley	42	32
Fresno	48	34
Long Beach	35	19
Los Angeles	570	358
Oakland	234	158
Pasadena	49	31
Riverside	16	22
Sacramento	100	86
San Diego	88	73
San Francisco	588	540
San Jose	41	33
Stockton	23	43
Selected groups:		
San Francisco	588	540
Oakland, Alameda and Berkeley	313	211
Total, Bay cities	901	751
Los Angeles	570	358
Neighboring cities	104	71
Total	674	429

Causes of Death.—The following table shows the classification of deaths in California for the current month, in comparison with the preceding month:

Deaths from Certain Principal Causes, with Proportion per 1,000 Total Deaths for Current and Preceding Month, for California: October.

Cause of Death.	Deaths: October	Proportion per 1,000. October	Proportion per 1,000. September
All causes	2,590	1,000.0	1,000.0
Typhoid fever	44	17.0	17.8
Malarial fever	11	4.2	6.7
Measles	2	0.8	1.6
Scarlet fever	3	1.2	1.2
Whooping-cough	13	5.0	4.0
Diphtheria and croup	10	3.8	4.3
Influenza	3	1.2	1.2
Other epidemic diseases	12	4.6	3.9
Tuberculosis of lungs	281	108.5	125.2
Tuberculosis of other organs	51	19.7	22.1
Cancer	172	66.4	69.5
Other general diseases	132	51.0	49.0
Meningitis	29	11.2	10.7
Other diseases of nervous system	206	79.5	74.2
Diseases of circulatory system	469	181.1	152.4
Pneumonia and broncho-pneumonia	156	60.2	50.6
Other diseases of respiratory system	51	19.7	16.2
Diarrhea and enteritis, under 2 years	121	46.7	44.2
Diarrhea and enteritis, 2 years and over	33	12.7	10.7
Other diseases of digestive system	139	53.7	66.4
Bright's disease and nephritis	130	50.2	63.6
Childbirth	20	7.7	12.2
Diseases of early infancy	103	39.8	36.3
Suicide	49	18.9	27.3
Other violence	211	81.5	82.9
All other causes	139	53.7	45.8

In Octobor there were 469 deaths, or 18.1 per cent of all, from diseases of the circulatory system, and 332, or 12.8 per cent, from various forms of tuberculosis. Heart disease thus led tuberculosis greatly.

Other notable causes of death were: Diseases of the digestive system, 293; violence, 260; diseases of nervous system, 235; diseases of respiratory system, 207; cancer, 172; Bright's disease and nephritis, 130, and epidemic diseases, 98.

The deaths from epidemic diseases were as follows: Typhoid fever, 44; whooping-cough, 13; malarial fever, 11; diphtheria and croup, 10; and all other epidemic diseases, 20.

The deaths from the four leading epidemic diseases reported for the month were distributed by counties as follows:

TYPHOID FEVER.	
Alameda	5
Colusa	1
Fresno	1
Glenn	1
Imperial	1
Kings	1
Los Angeles	6
Mendocino	1
Sacramento	3
San Bernardino	2
San Diego	2
San Francisco	8
San Joaquin	2
San Luis Obispo	1
Santa Barbara	1
Sonoma	3
Sutter	1
Tulare	3
Yuba	1
Total	44

WHOOPING-COUGH.	
Alameda	1
Los Angeles	1
Merced	1
Sacramento	1
San Bernardino	1
San Francisco	2
San Mateo	1
Ventura	5
Total	13

DIPHTHERIA AND CROUP.	
Alameda	2
Contra Costa	1
Fresno	1
Los Angeles	2
Sacramento	1
San Bernardino	2
San Joaquin	1
Total	10

MALARIAL FEVER.	
Alameda	1
Kings	1
Los Angeles	1
Placer	1
Sacramento	1
San Francisco	1
San Joaquin	1
Siskiyou	1
Sonoma	1
Tuolumne	1
Yolo	1
Total	11

Geographic Divisions.—The following table presents data for geographic divisions, including the metropolitan area, or San Francisco and the other bay counties (Alameda, Contra Costa, Marin, and San Mateo), in comparison with the rural counties of Northern and Central California:

Deaths from Main Classes of Diseases, for Geographic Divisions: October.

Geographic Division.	DEATHS: OCTOBER.										
	All Causes	Epidemic Diseases	Tuberculosis (All Forms)	Cancer	Diseases of Nervous System	Diseases of Circulatory System	Diseases of Respiratory System	Diseases of Digestive System	Bright's Disease and Nephritis	Violence	All Other Causes
THE STATE	2,590	98	332	172	235	469	207	293	130	260	394
Northern California	357	15	43	22	38	63	13	35	17	54	57
Coast counties	194	5	24	13	28	35	5	18	11	24	31
Interior counties	163	10	19	9	10	28	8	17	6	30	26
Central California	1,410	54	161	86	118	266	146	165	67	142	205
San Francisco	540	14	61	33	40	102	55	77	23	51	84
Other bay counties	302	14	31	21	23	53	39	31	17	29	44
Coast counties	174	3	20	16	15	39	13	14	12	19	23
Interior counties	394	23	49	16	40	72	39	43	15	43	54
Southern California	823	29	128	64	79	140	48	93	46	64	132
Los Angeles	546	13	93	44	43	98	38	63	32	42	80
Other counties	277	16	35	20	36	42	10	30	14	22	52
Northern and Central California	1,767	69	204	108	156	329	159	200	84	196	262
Metropolitan area	842	28	92	54	63	155	94	108	40	80	128
Rural counties	925	41	112	54	93	174	65	92	44	116	134

Morbidity Report for Octber, 1911.

Disease.	Cases.	Places.
Typhoid fever	196	30
Malarial fever	124	9
Smallpox	11	7
Measles	252	16
Scarlet fever	153	49
Whooping-cough	96	12
Diphtheria and croup	105	30
Influenza	42	4
Mumps	79	6
Tuberculosis of lungs	356	30
Glanders	5	1
Leprosy	1	1
Rabies	1	1
Poliomyelitis	1	1
Gonorrhœa	33	10
Syphilis	3	3
Trachoma	1	1

REPORT OF THE PURE FOOD AND DRUG LABORATORY.

By PROFESSOR M. E. JAFFA, Director.

The work of the State Food and Drug Laboratory for October comprised the usual routine examinations. The following cases were referred to district attorneys:

PURE FOOD AND DRUG CASES REFERRED TO DISTRICT ATTORNEYS NOVEMBER 4, 1911.

Name of Article.	Offense.	Manufacturer or jobber.	Accused Dealer.
Greens August Flower	Mislabeled. Contains ethyl alcohol not declared on label.	L. M. Green, Woodbury, N. J.	F. W. Murray, Corona.
Wakefield's Cough Syrup	Mislabeled. Contains alcohol and morphine not declared on label.	Dr. C. Wakefield & Co., Bloomington, Ill.	Red Bluff Drug Store, Red Bluff.
Dr. Gill's Botanic Syrup	Mislabeled. Contains morphine and chloroform not declared on label.	Scott & Gilbert, San Francisco	Red Bluff Drug Store, Red Bluff.
Fresh Eggs	Mislabeled. Not fresh eggs		Simon-Levi Co., Los Angeles.
Ranch Eggs	Mislabeled. Not fresh eggs		Newberry's, Los Angeles.
Pure Cider Vinegar	Mislabeled as to manufacturers	Pacific Preserve Co., San Francisco (Guarantors).	(Dealer protected by specific guaranty).
Eggs	Adulterated. Not fresh eggs		Goddard & Burrall, Los Angeles.
Jaquequina	Mislabeled. Contains acentanilid not declare on label	Brunswig Drug Co., Los Angeles (Guarantors).	(Dealer protected by specific guaranty).
Ballard's Horehound Syrup.	Mislabeled. Contains alcohol, morphine and chloroform not declared on the label.	Ballard Snow Liniment Co., St. Louis, Mo.	R. M. Green, Oroville.
Grove's Pepsin Coffee	Mislabeled. Contains ethyl alcohol not declared on label.	Paris Medicine Co., St. Louis, Mo.	R. M. Green, Oroville.

NOTICES OF JUDGMENTS.

The following Notices of Judgments have been received at the Laboratory since the publication of the last monthly bulletin; full copies of these may be obtained by addressing the Director of the State Food and Drug Laboratory, Berkeley, Cal.

Number of case and offense charged.	Name and address of defendant or manufacturer.	Specification of offense and disposition of case.
971—Misbranding of olives.	Vincenzo Arezzo, Raefale Arezzo and Claudio, N. Y.	Product consisted of a filthy, decomposed, and putrid animal or vegetable substance. Fine, $50.
972—Misbranding of a food product—"Crown Glossine."	Crown Manufacturing Co., N. Y.	Contained arsenous oxide, a substance injurious to health. Fine, $200.
973—Adulteration and misbranding of tomato paste.	Philadelphia Pickling Co., Eldora, N. Y.	Product consisted in whole or in part of a filty and decomposed vegetable substance. Ordered destroyed.
974—Adulteration of eggs.	Frederick Produce Co., Houston, Tex.	Product consisted wholly or in part of filthy, decomposed, or putrid substance. Ordered destroyed.
975—Misbranding of "Figprune Cereal."	Figprune Cereal Co., San Jose, Cal.	Label false and misleading. Released under $200 bond after paying costs.
976—Adulteration and alleged misbranding of evaporated apples.	Simpson-Mintun Fruit and Produce Co.	Product consisted of filthy, decomposed and putrid matter. Ordered destroyed.
977—Misbranding and alleged adulteration of vinegar.	Louisiana Molasses Co., New Orleans, La.	Water had been added to and substituted for said product. Released under $250 bond after paying costs.
978—Adulteration and misbranding of evaporated apples.	F. A. Hihn Co., Santa Cruz, Cal.	Product consisted in part of filthy, decomposed and putrid animal and vegetable matter. Ordered destroyed after paying costs.
979—Adulteration and misbranding of condensed milk.	O. E. Sharpless Co., Philadelphia, Pa.	Product adulterated because a valuable constituent of the article, to wit: butter fat, had been in part abstracted. Label false. Released under $3,300 bond, paying costs.
980—Misbranding of cheese.	District Columbia.	False and misleading statements. Released under bond after paying costs.
981—Misbranding of coffee.	Wm. B. Carhart and H. B. Carhart, N. Y.	Labeled Mocha and Java, whereas it consisted of Dutch East Indian and Bogota coffee. Fine, $25.
982—Misbranding of drug product—"Walker's Tonic."	Walker's Tonic Co., Paducah, Ky.	Label false and misleading. Fine, $25.
983—Adulteration and misbranding of vanilla extract.	Manhattan Importing Co., Cleveland, O.	Imitation extract of vanilla. Ordered destroyed.

REPORT OF THE STATE HYGIENIC LABORATORY FOR OCTOBER.

By Wilbur A. Sawyer, M. D., Director.

RABIES.

In the report submitted for the month of September it was shown that the present epidemic of rabies among dogs was spreading rapidly northward and that the disease had just been proved to exist in Merced County. During October rabies made its appearance in Stanislaus

County as proved by the finding of Negri bodies in a dog's brain sent from there. The precautions taken against the spread of this disease are obviously insufficient.

For some months the State Board of Health and the Director of the Laboratory have endeavored to protect Northern California and the region about San Francisco Bay from rabies, by urging and directing special activity against the disease in the northernmost counties affected. In many of the towns and most of the counties, efficient muzzling ordinances have not yet been enacted and enforced. As a result, during the past eleven months the infected area has increased from a limited region south of Tehachapi through Kern, Tulare, Kings, Fresno, Madera, and Merced counties, to Stanislaus County. Previous to this extensive epidemic the disease existed temporarily in a small area in San Joaquin County and a single case was found in Contra Costa County. It is probable that these regions will now be reinfected unless the present epidemic is curbed.

An isolated case was found in October in San Francisco. The brain of a pet dog, which had died with suggestive symptoms three weeks after being bitten by a strange dog, was sent to the laboratory. Examination proved that the disease was rabies. As far as is known this is the first appearance of rabies in San Francisco.

During October examinations at the laboratory showed the disease to be present in the following counties: San Francisco, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern.

ANTHRAX.

Microscopic and cultural examinations revealed the presence of anthrax bacilli in blood and tissue from cattle dying in San Joaquin and Tulare counties.

Summary of Examinations made in the California State Hygienic Laboratory during the month of October, 1911.

Main Laboratory at Berkeley:

Condition suspected:	Positive.	Negative.	Total
Anthrax	6	1	7
Diphtheria	5	25	30
Gonococcus Inf.	1	1	2
Malaria	--	4	4
Plague	--	1	1
Rabies	10	1	11
Tuberculosis	3	17	20
Typhoid	16	30	46
Water Pollution	1	1	2
Miscellaneous	2	2	4
			127

Central California Branch at Fresno:

Condition suspected:	Positive.	Negative.	Total.
Diphtheria	2	3	5
Tuberculosis	1	--	1
Typhoid	1	--	1
			7

Southern California Branch at Los Angeles:

Condition suspected:	Positive.	Negative.	Total.
Diphtheria	2	2	4
			4

Total number of examinations	138

LIST OF COUNTY HEALTH OFFICERS.

County.	Health Officer.	Address.
Alameda	Dr. C. L. McKown	Niles
Alpine*	County Recorder Frank Smith	Markleeville
Amador	Dr. E. E. Endicott	Jackson
Butte	Dr. L. Q. Thompson	Gridley
Calaveras	Dr. E. W. Weirich	Angels Camp
Colusa	Dr. C. A. Poage	Colusa
Contra Costa	Dr. F. S. Gregory	Pittsburg
Del Norte	Dr. E. M. Fine	Crescent City
El Dorado	Dr. L. M. Leisenring	Placerville
Fresno	Dr. W. T. Burks	Fresno
Glenn	Dr. J. A. Randolph	Willows
Humboldt	Dr. E. H. Bryant	Eureka
Imperial	Dr. Virgil McCoombs	El Centro
Inyo	Dr. I. J. Woodin	Independence
Kern	Dr. G. M. Bumgarner	Bakersfield
Kings	Dr. Ralph Motherol	Hanford
Lake	Dr. W. E. Upton	Kelseyville
Lassen	Dr. W. E. Dozier	Susanville
Los Angeles	Dr. E. O. Sawyer	Los Angeles
Madera	Dr. Mary R. Butin	Madera
Marin	Dr. J. H. Kuser	Novato
Mariposa	Dr. F. L. Wright	Mariposa
Mendocino	Dr. J. Liftchild	Ukiah
Merced	Dr. C. H. Castle	Merced
Modoc	Dr. John Stile	Alturas
Mono*	County Recorder Geo. Delury	Bridgeport
Monterey	Dr. Garth Parker	Salinas
Napa	Dr. E. Z. Hennessey	Napa
Nevada	Dr. Carl P. Jones	Grass Valley
Orange	Dr. John Wehrly	Santa Ana
Placer	Dr. O. L. Barton	Loomis
Plumas	Dr. F. D. Walsh	Quincy
Riverside	Dr. George E. Tucker	Riverside
Sacramento	Dr. Hugh Beattie	Elk Grove
San Benito	Dr. J. M. O'Donnell	Hollister
San Bernardino	Dr. Philip M. Savage	San Bernardino
San Diego	Dr. Nathan Hunt	San Diego
San Francisco	Dr. R. G. Brodrick	San Francisco
San Joaquin	Dr. Wm. Friedberger	Stockton
San Luis Obispo	Dr. H. M. Cox	San Luis Obispo
San Mateo	Dr. W. G. Beattie	Colma
Santa Barbara	Dr. J. C. Bainbridge	Santa Barbara
Santa Clara	Dr. William Simpson	San Jose
Santa Cruz		Santa Cruz
Shasta	Dr. F. Stabel	Redding
Sierra	Dr. R. B. Davy	Downieville
Siskiyou	Dr. F. J. McNulty	Yreka
Solano	Dr. S. G. Bransford	Suisun
Sonoma	Dr. P. A. Meneray	Santa Rosa
Stanislaus	Dr. F. R. De Lappe	Modesto
Sutter	Dr. J. McFadyen	Yuba City
Tehama	Dr. J. S. Cameron	Red Bluff
Trinity	Dr. D. B. Fields	Weaverville
Tulare	Dr. M. E. Pettit	Visalia
Tuolumne	Dr. Wm. Lyman Hood	Sonora
Ventura	Dr. A. A. Maulhardt	Oxnard
Yolo	Dr. W. J. Blevins	Woodland
Yuba	Dr. J. H. Barr	Marysville

LIST OF CITY HEALTH OFFICERS.

City.	Health Officer.
Alameda	Dr. A. Hieronymus
Albany	Dr. Robt. Hector
Alhambra	Dr. F. E. Corey
Alturas	Dr. John Stile
Alviso	—— ——
Anaheim	Dr. J. L. Beebe
Antioch	Dr. W. S. George
Arcadia	—— ——
Arcata	Dr. G. W. McKinnon
Arroyo Grande	—— ——
Auburn	Jas. H. Breslin
Azusa	Dr. L. W. Atkinson
Bakersfield	S. D. Mullins
Belvedere	Dr. Florence Scott
Benicia	Dr. W. L. McFarland
Berkeley	Dr. J. J. Benton
Biggs	Dr. B. Caldwell
Bishop	Dr. J. W. Shute
Blue Lake	Dr. G. N. Wood
Brawley	Dr. L. L. Lindsey
Burbank	—— ——
Burlingame	—— ——
Calistoga	—— ——
Calexico	Dr. Wm. F. Smith
Chico	G. H. Taylor
Chino	Dr. John W. Callnon
Claremont	—— ——
Cloverdale	F. P. Conner
Coalinga	Dr. H. S. Warren
Colfax	Silas Ulery
Colton	Dr. J. A. Champion
Colusa	Dr. C. A. Poage
Compton	J. W. Stone
Concord	Dr. F. F. Neff
Coram	Geo. H. Thomas
Corning	Dr. W. F. Maggard
Corona	Dr. W. H. Chapman
Coronado	Dr. Raffaele Lorini
Cottonwood	Dr. A. B. Gilliland
Covina	—— ——
Crescent City	—— ——
Daly City	—— ——
Davis	Dr. W. E. Bates
Delano	Dr. H. Hildreth
Dinuba	Dr. Wm. Whittington
Dorris	Dr. A. A. Atkinson
Dixon	W. C. Rhem
Dunsmuir	Dr. E. J. Cornish
Eagle Rock	Dr. C. H. Phinney
Elsinore	Dr. Hugh Walker
Emeryville	Dr. A. T. Drennan
Escondido	Dr. David Crise
Etna Mills	Dr. W. H. Haines
Eureka	Dr. L. A. Wing
Exeter	Dr. A. D. McLean
Fairfield	Dr. S. G. Bransford
Ferndale	Dr. C. A. Phelan
Fort Bragg	Dr. L. C. Gregory
Fort Jones	Thos. Bransom
Fortuna	Dr. Geo. S. Loveren
Fowler	Dr. W. T. Crawford
Fresno	Dr. Geo. H. Aiken
Fullerton	Dr. F. J. Gobar
Gilroy	Dr. John A. Clark
Glendale	Dr. R. E. Chase
Grass Valley	Paul E. Sears
Gridley	Dr. L. L. Thompson
Hanford	Dr. R. W. Musgrave
Hayward	Dr. G. E. Reynolds
Healdsburg	Dr. J. W. Seawell
Hemet	Dr. A. B. Eadie
Hermosa Beach	E. McCaskey
Hercules	Dr. M. L. Fernandez
Hillsborough	—— ——
Hollister	Dr. R. G. Curtis
Hollywood	E. O. Palmer
Huntington Beach	C. F. Sorenson
Huntington Park	Dr. W. Thompson
Imperial	Dr. C. E. Standlee
Inglewood	Dr. H. A. Putnam
Jackson	F. V. Sanguinetti
Kennett	Dr. J. P. Sandholdt
Kernville	—— ——
King City	—— ——
Kingsburg	—— ——
Lakeport	Jabez Banks
Larkspur	—— ——
Lincoln	F. R. Elder
Lindsay	Dr. W. W. Tourtillot
Livermore	Dr. H. G. McGill
Lodi	Dr. F. W. Colman
Long Beach	Dr. W. H. Newman
Lompoc	—— ——
Lordsburg	Dr. J. E. Hubble
Los Angeles	Dr. L. M. Powers
Los Banos	Dr. J. L. McClelland
Los Gatos	Dr. C. K. Small
Loyalton	Dr. G. L. Coates
Madera	Dr. Mary R. Butin
Maricopa	Dr. H. N. Taylor
Martinez	Dr. E. E. Brown
Marysville	Wm. Meek
Mayfield	Dr. F. M. Seibert
McCloud	Dr. R. T. Legge
McKittrick	G. M. Chitwood
Merced	Dr. C. H. Castle
Mill Valley	Capt. M. Staples
Modesto	Dr. J. J. Knowlton
Montague	—— ——
Mojave	A. Smith
Monrovia	Dr. R. D. Adams
Monterey	Edward Allen
Morgan Hill	Dr. D. W. Watt
Mountain View	Dr. A. H. McFarlane
Napa	J. D. Treadway
National City	Dr. T. F. Johnson
Nevada City	Hugh Murchie
Newman	Dr. H. V. Armistead
Newport Beach	—— ——
Oakdale	Elmer E. Endicott
Oakland	Dr. E. N. Ewer
Ocean Side	Dr. R. S. Reid
Ocean Park	Dr. W. M. Kendall
Ontario	Dr. C. S. Orr
Orange	Dr. F. L. Champline
Orland	Dr. S. Goldman
Oroville	Dr. W. F. Gates
Oxnard	Dr. Ralph W. Avery
Pacific Grove	E. B. Richi
Palo Alto	Hubert O. Jenkins
Pasadena	Dr. Stanley P. Black
Paso Robles	B. B. Pierce
Perris	A. F. Hardy
Petaluma	Dr. J. M. Proctor
Pinole	J. Chattleton
Pittsburg	Dr. F. S. Gregory
Placerville	P. J. Hall
Pleasanton	Dr. S. J. Wells
Pomona	Dr. T. J. Wilson
Porterville	Dr. O. C. Higgins
Piedmont	Geo. T. Burtchael
Point Arena	—— ——
Potter Valley	—— ——
Randsburg	E. B. McGinnes
Red Bluff	Dr. F. J. Bailey
Redding	L. D. Poole
Redlands	Dr. Chas. E. Ide
Redondo Beach	Dr. D. R. Hancock

City.	Health Officer.
Redwood City	Dr. J. L. Ross
Richmond	Dr. Chas. R. Blake
Rio Vista	Dr. A. J. McKinnon
Riverside	Dr. Thos. R. Griffith
Rocklin	Dr. S. P. Rugg
Roseville	Dr. R. H. Ashby
Ross	
Sacramento	Dr. Wm. K. Lindsay
Saint Helena	G. B. Anderson
Salinas	S. A. McCollum
San Anselmo	Dr. Chipman
San Bernardino	Dr. C. V. McConnico
San Diego	Dr. F. H. Mead
San Francisco	Dr. R. G. Brodrick
Sanger	Dr. T. F. Madden
San Jose	Dr. M. F. Hopkins
San Jacinto	Thos. Lloyd
San Juan	Henry Drake
San Luis Obispo	Dr. P. L. Rookledge
San Rafael	Dr. W. F. Jones
San Mateo	Dr. S. G. Goodspeed
San Leandro	P. C. Du Bois
Santa Ana	Dr. J. I. Clark
Santa Barbara	Dr. D. A. Conrad
Santa Cruz	Dr. H. E. Piper
Santa Clara	Dr. J. F. Beattie
Santa Monica	Dr. W. H. Parker
Santa Paula	Dr. G. E. ApLynne
Santa Rosa	Dr. Jackson Temple
Santa Maria	Dr. O. P. Paulding
Sausalito	Dr. A. H. Mays
Sawtelle	Dr. A. B. Hromadka
Selma	Dr. F. H. Williams
Sierra Madre	Dr. R. H. Mackerras
Sebastopol	Dr. J. J. Keating
Sisson	Dr. G. L. Gouguet
South Pasadena	Dr. C. A. Whiting
South San Francisco	Dr. H. G. Plymire
Stockton	Dr. R. T. McGurk
Susanville	Dr. E. S. Drucks
Suisun	
Stanton	
Sonoma	
Taft	E. G. Wood
Tehachapi	R. M. Spencer
Tracy	Dr. J. G. Murrell
Tehama	
Tropico	
Tulare	Dr. J. B. Rosson
Turlock	Dr. E. L. Clough
Ukiah	Dr. J. Liftchild
Upland	W. C. Redman
Vacaville	Dr. A. P. Finan
Vallejo	Dr. E. A. Peterson
Ventura	J. H. Hardey
Visalia	Dr. M. L. Pettit
Watsonville	Dr. F. H. Koepke
Watts	Dr. E. J. Richie
Wheatland	Dr. A. W. Foshay
Whittier	Dr. W. H. Stokes
Willits	Dr. W. L. Blodgett
Willows	Thos. Kinkade
Winters	Dr. J. H. Haile
Woodland	Peter Scott
Yreka	E. W. Nolan
Yuba City	

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